Annual Report 1959

Northeastern Forest Experiment Station

FOREST SERVICE • U. S. DEPARTMENT OF AGRICULTURE • UPPER DARBY, PA.

1959
Annual Report

Northeastern Forest Experiment Station

Contents

In general	1
Forest management and fire research	4
Watershed management	25
Forest insects	33
Forest diseases	42
Forest economics	50
Forest utilization	57
Publications	63

NORTHEASTERN FOREST EXPERIMENT STATION • • 1960

RALPH W. MARQUIS, DIRECTOR

In General...

THE format of our Annual Report this year is unchanged. An informal opinion poll of a sample of our readers showed that our practice of reporting highlights was satisfactory, and that relative brevity was preferred to complete coverage of all activities. So again we invite you to consult our publications or to ask us for more information if some phase of our work that interests you is not completely covered in these pages.

RESEARCH PROGRAMS

The hopeful forecast in our 1958 report that we might soon be engaged in forest recreation and wildlife habitat research turned out to be correct. Funds for these activities were provided in the Supplemental Appropriations Act.

Funds for the new work were allotted to us October 5, 1959. Thanks to our advance analyses and planning, along with some recruiting on an if-and-when basis, we were in operation, fully staffed, in new center headquarters on the Biddle Demonstration Forest Area by Nov. 2. The new program is discussed in the section on Forest Management Research.

With completion of calibration on the Dilldown and Pocono watersheds, the program at Kingston, Pa. has been reoriented. Cooperative watershed management research has been transferred to New Lisbon, N.J. The emphasis on forest management studies at Kingston has been lessened and, in keeping with the expressed needs of the area, more attention is being given to recreation and wildlife habitat research under the direction of the Warren Center.

EXTENSION OF RESEARCH RESULTS

No one has ever questioned the responsibility of research workers to prepare the results of their investigations for publication. But there is some difference of opinion as to how far a research organization should go in answering inquiries, in preparing and delivering papers, and particularly in conducting visitors to research installa-

tions and explaining studies and results. Right or wrong, we are in the business.

During the past year our publication activity increased. Our mailing list for publications grew from 1,440 to 2,550 individuals. This resulted partly from a deliberate attempt to find a larger audience for our research results. To this end, 11 news releases were sent to more than 600 newspapers and periodicals. These resulted in numerous requests for publications. Some 2,750 requests for publications were received by mail--a marked increase over previous years. Some of these asked for as many as 119 different publications; some asked for as many as 1,000 copies of a single publication. In all, about 75,000 individual copies of publications were mailed out during the year either in regular distributions to our mailing list or in reply to requests. Most of this total was made up of 46 publications printed in our own printing plant. Besides these, 60 research reports were published in technical journals and periodicals, and 15 were published by other agencies. It is impossible to measure the reader audience for all this material, but we do know that the audience is growing.

Reports from the field have indicated a constantly increasing volume of requests for information that could not be answered by the simple expedient of providing a publication. Instead, these requests require an individually prepared letter, the preparation of a speech, or a show-me expedition to a research installation. To measure this demand we canvassed all Station personnel engaged in research and came up with the following results:

During 1959 the various units of the Station scheduled 185 show-me trips and conducted 2,925 visitors on these trips. In addition, 800 drop-in visitors were taken on unscheduled trips. Station personnel prepared 106 technical papers for presentation at meetings of organizations, societies, clubs and forums. More than 1,600 requests for information came to us by telephone or personal visit. And 2,340 letters were written in answer to inquiries.

The impact of these activities on project research can readily be visualized. Whether we look on them as interruptions or as welcome opportunities to inform the public, we must accept the fact that as our knowledge grows and as others' interest increases, the demands will be greater.

STATION AFFAIRS

Disaster came close several times this year. Bill Borneman and Bill Gabriel were in a Sunday afternoon auto-

mobile accident near Burlington, Vt. Both are back on the job. Heavy storms in New Hampshire washed out forms for a new weir at Hubbard Brook, filled weir basins with debris, and washed out a bridge and part of a road. Damage repaired. The cornice and part of the exterior brick facing of our headquarters building in Upper Darby came crashing down in July. No one hurt. But since then, as repairs and replacement take place, we have been living with jack hammers, electric drills, shattering glass, plywood walls, humidity, and dust. To date, no resignations.

Four of our technical men left the Station during the year. Ray Brown retired, Wayne Banks accepted appointment on an I.C.A. Operations Mission in Laos, Kenneth Bromfield returned to the Biological Warfare Laboratory at Fort Dietrich, and Dick Lane transferred to the Washington Office.

Nine technical men joined our staff. Four are new to the Forest Service and five transferred from other units. Five brought Ph.D. degrees with them. Joining the staff at Warren, Pa., were Hubert Burke (center leader) Alan Wagar (recreation research), and James Jordan (wildlife habitat research). Alex Shigo (forest disease research) is at Laconia, James Lowe (forest insect research) at New Haven, Carter Biggs (forest management) at Elkins, and Clayton Carl (forest management) at Paul Smiths. Barney Dowdle (economics) and Warren Doolittle (forest management) are in Upper Darby.

Grant Davis and Edward Sucoff resumed full-time work after returning from educational leave. Herbert Tepper is on leave at the University of California this year, and Don Lester is at Yale. The number of employees at educational institutions is seven.

Forest Management and Fire Research

DURING the past year, two important changes were made in the work of the Division of Forest Management and Fire Research. Foremost was the beginning of a new regional program of research in recreation and wildlife habitat for the Station's 12-state area. The other important change was the reorganization of our compartment management program--a change that has been brewing for about 3 years and which, for the most part, took place during the past year. The details of these changes and summaries of our work on fire and other aspects of our program are covered in later sections of this report.

New activities and progress in some of our more important projects during the year are as follows:

- Studies of wood density of the principal native softwoods of Maine and New Hampshire have been begun at our Bangor Research Center in cooperation with a number of wood-using industries, the University of Maine, and the U. S. Forest Products Laboratory. The Laboratory is also cooperating with the Station in testing wood density, fibril angle, and gelatinous fiber concentration in provenance tests of red pine and green ash, and in outplantings of a number of hybrid poplar clones.

- Exploratory work on white pine growth relationships has been expanded into a cooperative project with the Universities of Maine, New Hampshire, and Massachusetts. About 300 plots are planned on which growth, stand conditions, and site characteristics will be observed.

- As a step toward expanding research on the management of second-growth northern hardwoods, a study in 25-year-old stands at the Bartlett Experimental Forest has been started to test several thinning methods for their effect on crop-tree quality and growth.

- Our Paul Smiths Research Center and the St. Regis Paper Company established a series of 2½-acre plots on the Northern New York Experimental Forest to study and demonstrate the extent of loss of hardwood regeneration to deer

browsing. Additional research in wildlife habitat is planned for next year.

- Tree-planting studies on strip-mine banks in the Pennsylvania bituminous coal fields are being continued this year in 10-year-old plantings on leveled banks and in older plantings on unleveled banks (in cooperation with Pennsylvania State University, Pennsylvania Department of Forests and Waters, Pennsylvania Department of Mines and Mineral Industries, the Izaak Walton League, and the Independent Mineral Producers Association).

- Our New Lisbon Research Center, with a long history of research in softwoods, recently began work with hardwoods. This includes studies of soil-site in sweetgum stands, the survival and growth of yellow-poplar seedlings, regeneration cuttings in oak, and thinning in stands of several hardwood species.

- As a demonstration of a simple, practical method of managing small forest properties in the northern Appalachians, a management unit of 600 acres was set up on our Fernow Experimental Forest. The management plan has been drawn up, and the first annual cuts have already been made.

RECREATION, WILDLIFE HABITAT, AND MULTIPLE USE

Our new research center at Warren, Pa.--the first Forest Service unit with recreation research as its primary program--was established in August 1959. This new center also conducts research in wildlife habitat, and continues the timber-management research programs of the Kingston and Kane Centers, which were merged with it. The office of the Kingston unit remains in Kingston, Pa.; research work on the Kane Experimental Forest is now headquartered at Warren.

The Warren Research Center has four missions: (1) forest recreation research for the 12 states of the Northeast; (2) wildlife habitat research for the 12 states of the Northeast; (3) timber-management research in northern Pennsylvania and southwestern New York; and (4) jointly with the Allegheny National Forest to plan, establish, and maintain demonstrations of multiple-use forestry on the newly acquired Biddle Demonstration Forest Area.

Biddle Demonstration Forest Area

The office of the Warren Center is located on the Biddle Demonstration Forest Area, a 600-acre tract that was donated to the Forest Service by the Lydia S. Biddle Estate. Located about 6 miles west of Warren on the Allegheny River

at the mouth of Brokenstraw Creek, the Biddle Forest is one of the richest historical sites in northwestern Pennsylvania. Demonstrations on the forest will include the integration of recreation, wildlife, and water with timber production. Preliminary plans have been made for the development of a training headquarters, a historical museum, and an exhibit center for depicting various aspects of the multiple-use story in forestry. One portion of the forest along the Allegheny River is being developed as a recreation area called the "Buckaloons", named for a Seneca village that once occupied the site.

Research

Since the primary research effort at the Warren Research Center is in recreation and wildlife, the older research programs in timber management at Kane and Kingston will not be discussed here. However, some of the more pertinent results and activities in timber management at these units during the past year are covered in a later section.

Forest Recreation

The immediate effort in recreation research has been to prepare a regional problem analysis for the Northeast, and to begin studies on several of the most pressing problems in recreation. The task of preparing the problem analysis has been greatly simplified because of an earlier analysis by Dana; a subsequent analysis for the Northeast by Lane; the National Forest Outdoor Recreation Resources Review work plan; and the cooperation of the Northeastern Forest Experiment Station's Advisory Council, which devoted its 1959 meeting to the subject of recreation and its research needs.

As outlined in Lane's analysis, the five most pressing needs in recreation research are:

- To determine how to measure recreation use.
- To develop guides and criteria for selecting and developing new recreation areas--especially for camping and picnicking.
- To determine how recreation use, under management, can be integrated and harmonized with timber, water, and wildlife uses.
- To determine user preferences in outdoor recreation.
- To establish pilot-operation areas for outdoor recreation research and demonstrations.

So far, two studies have been started in recreation research at Warren. The first is an exploratory study of soil compaction in recreation areas. Observations are made with a cone penetrometer. A series of readings taken recently in the Heart's Content Scenic Area showed, as expected, a high degree of compaction in and near trails, as compared to adjacent areas subjected to little or no traffic. Measurements were taken just before the ground froze, and remeasurements after the spring thaw should give an indication of the effectiveness of frost action in alleviating soil compaction.

A second study deals with recurring recreation problems at nine highly developed forest-recreation areas in Pennsylvania, New York, and New Hampshire. Personnel from the Warren Center are interviewing superintendents and park managers of these selected areas. The analysis, summary, and interpretation of these data should point to the solution of some of the problems and will also guide research on those problems that cannot be readily solved.

Among the many problems emphasized by park and recreation administrators, one that has been underscored is the erosion of swimming beaches. Several designs have been tried in the past to reduce the high cost of beach installation and maintenance. Research is needed to design, develop, and maintain beaches that fit forest recreation requirements, prevent erosion, and allow a minimum movement of subgrade material up through the sand.

Wildlife Habitat

As in recreation research, high priority in wildlife habitat has been assigned to the preparation of a problem analysis for the Northeastern region and the installation of initial studies on several of the most pressing and important problems. Although in many aspects wildlife is a part of forest recreation, it is logically separated from recreation because it requires personnel with specialized training in wildlife. Again, according to Lane's analysis, the most pressing needs in wildlife-habitat research are:

- To determine methods of managing for maximum habitat development where timber is a secondary crop.
- To determine the wildlife-carrying capacity of forests managed for timber and water as primary products.
- To determine how manipulation of forest cover affects wildlife and fish.
- To determine the damage to forest regeneration from deer browsing.

- To determine how to control deer damage to forest regeneration.

Three studies in wildlife habitat research were begun recently by the Warren Center. One is on the development and utilization of game food and the concurrent establishment of black cherry reproduction. Clear-cutting in strips is being tried on an experimental timber sale.

In a second study of winter deer browse, several existing deer exclosures are being used. Two 3- and 4-year-old exclosures in clear-cut strips on the Allegheny National Forest and two 25-year-old exclosures on the Kane Experimental Forest are being studied to develop techniques of measuring woody vegetation, and preliminary estimates are being made of the time required for black cherry to reach a height at which protection from deer browsing is no longer necessary.

A third study consists of a review and inspection of the different types of deer fences in respect to design, effectiveness, and cost. Unless and until research is able to develop management methods that prevent or minimize deer browse damage, some type of deer fencing may be necessary in the early stages of forest regeneration. Both private and public forest administrators are searching for answers to this problem. Of particular interest is an experimental fence constructed of pulpwood bolts by the Armstrong Forest Company on their land.

LARGE-SCALE TESTS IN FOREST MANAGEMENT

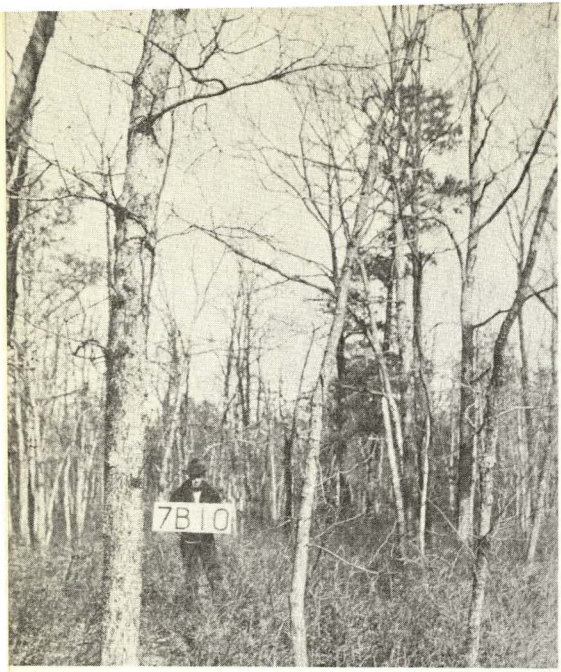
Since World War II, large-scale tests of forest management methods, better known as compartment studies, have been made by various research agencies all over the country. During this period seven such tests were made at field units of the Station. Today, after more than 10 years, we have stopped long enough to take a second look at our entire compartment program.

Here's what we see. Our compartment studies have had immeasurable demonstration and educational value in getting the results of forest research into practice and in raising the general level of forest management in the region as a whole. Our best planned compartment studies are truly comparative tests in a statistical sense, because they do test two or more replicated treatments. These tests have turned up new and important problems vital to the success of the overall program and which, without the tests, might even still be unknown.

TERRAIN MODEL of the Biddle Demonstration Forest Area near Warren, Pa., where a new research program in recreation and wildlife habitat has been begun.

SOIL COMPACTION is a major problem in most recreation areas. A cone penetrometer is being used here to gage compaction.

TO PROTECT seedlings of good timber species from deer browsing, this fence of peeled pulpwood around a 234-acre tract is being tested by the Armstrong Forest Company near Johnsonburg, Pa.



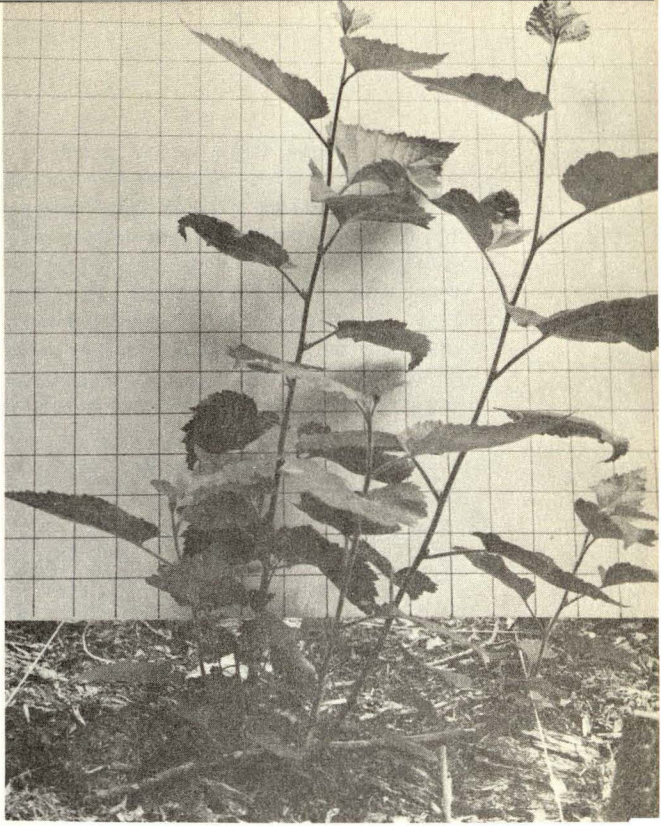
↑ *A PLOT in an oak-pine stand in 1936, before treatment.*

THE SAME plot in 1946, after ten annual winter burns. ↑

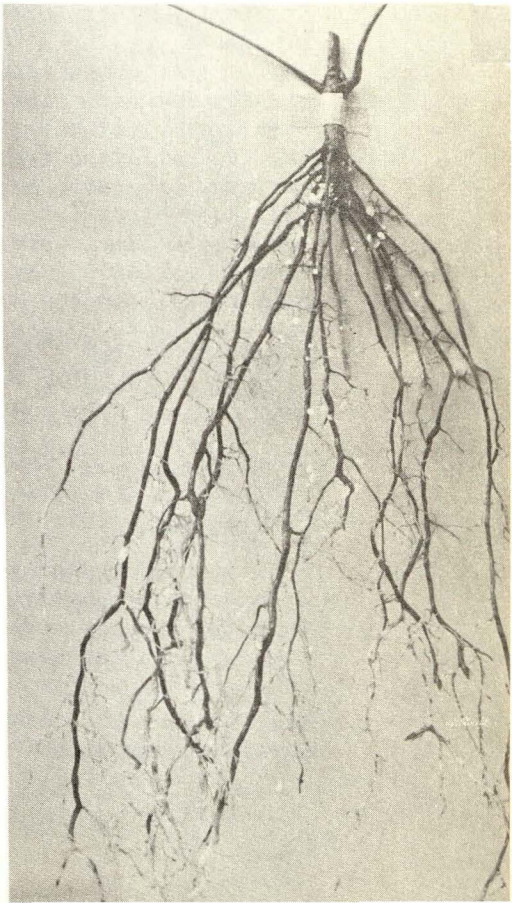
RESULTS OF PRESCRIBED BURNING IN SOUTHERN NEW JERSEY

↓ *THE SAME plot 5 years after all oaks were cut and sold, with 4,100 pine seedlings per acre, all a result of natural regeneration.*

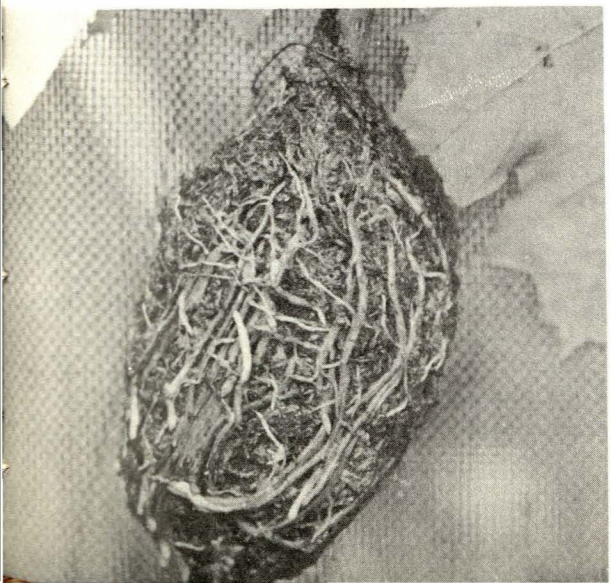
IN A TEST of germination and survival on different types of seedbeds, this paper birch seedling, on humus, exhibited excellent height growth--nearly 14 inches in 3 months. →



SUGAR MAPLE cuttings rooted better in perlite than in other media. Note the good root system here. →



FAIR SUCCESS has been obtained in air-layering of sugar maple. ↓



These test areas have provided conditions and opportunities for superimposing supplementary and special studies with a minimum of further research effort. Studies of growth by plots, watershed management, logging cost, and logging damage are but a few of the more important examples. The sum total of knowledge yielded by these large-scale tests and the subsidiary small-scale studies has enabled us to come up with some of the answers to the most basic objectives of compartment studies--the biologic and economic comparisons of the different methods of treatment.

At the same time, we also see growing importance for other studies of a basic nature, many of which either require laboratory techniques or other conditions not available on compartments. So, during the past 3 years, while we were taking that second look, we have also been busy revising and revamping our entire system of large-scale tests, with the idea of streamlining them to make treatments more realistic, improve the experimental design, reduce the total workload, and give our researchers more time for other work.

The results of this effort have been to abolish large-scale tests at four field units, where the studies were weak and could not be strengthened because of either manpower or research area limitations. However, some of the original compartments are being carried along as simple case histories at three of these four units. At a fifth field unit, the compartment study has been retained, but with greatly reduced size and scope; this unit also has several case history studies, adapted from parts of the older study. The two remaining field units still retain rather large compartment programs, but revision and streamlining have sharpened the objectives, made the treatments more realistic, reduced compartment size (to 25-50 acres), recognized additional variables, and--especially--improved the design for statistical comparison of treatments.

In citing one example of our modern compartment studies (Parsons, West Virginia) we list its objectives as follows:

- The principal objective is to compare net roadside returns from timber yields for several forest management treatments.
- Secondary objectives are: (1) to determine the yield, species composition, and timber quality by site-quality classes; and (2) to determine the effects of treatment on the cost of logging.

The treatments, cutting cycles, site-index variables, and number of compartments in this study are as follows:

Treatment	Site index (oak)			
	60	70	80	Total
	No. compartments--			
Clear-cut	0	2	2	4
Diameter-limit cut	3	3	3	9
Extensive selection				
10-year cutting cylce	2	2	3	7
20-year cutting cycle	3	2	3	8
Intensive selection				
5-year cutting cycle	0	2	3	5
Flexible cutting cycle	2	2	3	7
Total	10	13	17	40

Other variables in this study, included in the treatments above, are residual basal areas (retained after cutting) in sawtimber-size trees, ranging from 40 to 70 square feet per acre; maximum size tree to be retained, ranging from 20 to 32 inches d.b.h.; and q-factors ranging from 1.3 to 1.7. These basal areas, maximum tree sizes, and q-factors vary according to site index and treatment.

In summary, as a result of our compartment program review, we feel that we have accomplished at least four things: (1) removed the weak compartment studies, (2) improved the ones that were retained, (3) decreased the manpower workload on compartments by about one-third, and (4) made this extra manpower available for other studies.

FIRE

Twenty years ago the use of fire in forest management was frowned upon by many foresters--very vehemently by some --despite strong evidence that fire favored the perpetuation of several valuable forest types. Today fire is accepted by most foresters as a useful management tool, although admittedly it is a dangerous tool to handle and is applicable only in certain areas. Prescribed fire may be used for either or both of two purposes: (1) as a silvicultural treatment, and (2) as an aid in controlling wildfires.

In the Northeastern Station's territory, prescribed burning for both purposes has been used most extensively in the New Jersey pine region, an area of sandy, fast-drying soils that is highly subject to disastrous wildfires. Pitch and shortleaf pines are the predominant conifers. It has been used to a lesser extent as a silvicultural treatment on the Eastern Shore of Maryland, a region characterized by moist, poorly drained soils, where loblolly and pond pines are the predominant conifers. Because of the moist soils, there is little need on the Eastern Shore for prescribed

burning for wildfire control. On the Beltsville Experimental Forest, which, strictly speaking, is lower Piedmont rather than Coastal Plain, prescribed burning also has been attempted in a small way in Virginia pine stands.

Silvicultural Treatments

The main purpose of fire as a silvicultural treatment in the New Jersey and Maryland Coastal Plain sections is to inhibit the establishment and development of hardwood reproduction in areas where such reproduction is undesirable and to establish pine (or, on certain sites, Atlantic white-cedar) regeneration in a dominant position. When used under growing timber stands, fire serves this purpose by (1) reducing the volume of litter and humus, thereby creating seedbeds favorable for germination and initial establishment of desired conifers, and (2) killing or suppressing competitive hardwood understories. In certain situations fire may be used after harvest cuttings to dispose of slash and litter, to improve seedbed conditions, or to increase the efficacy of mechanical methods of seedbed improvement, such as disking.

For use under timber stands, fire is prescribed either as a light winter burn, or as a hot and deep-burning summer or fall treatment. Since the latter type of fire may damage the crowns and roots of crop trees, this treatment usually is applied but once during a rotation, near the time of harvest cutting. Light winter burns, on the other hand, do little or no damage to crop trees; they usually are applied periodically as required to hold the understory hardwoods in check, and to create favorable seedbeds for regeneration as the end of the rotation is approached. The intervals between burns ordinarily are 3 to 5 years. Such burning regimes yield a double dividend in that the consumption of ground fuels lessens the risks of stand destruction by wildfires.

Uses Of Periodic Light Winter Fires

This system of prescribed burning finds use in three forest cover types in New Jersey, as discussed separately below:

Oak-pine: This upland type is the most common one in the Jersey pine region. With care, light winter fires can be used periodically in this type as soon as the crop trees exceed 2 inches d.b.h. Larger trees, of course, will tolerate somewhat hotter fires than smaller ones.

In older stands, advance pine reproduction becomes established on the burn-prepared seedbeds. Once pitch or

shortleaf pine seedlings have developed their characteristic basal crooks, they can survive subsequent fires by sprouting from basal buds. Hence, under periodic burning, pine reproduction tends to increase, particularly in the more open stands. Data from two studies have shown increases of roughly 500 seedlings per acre, after cutting, for each burn made before cutting.

Since sprouting vigor of the oaks declines with age, prescribe-burned old oak-pine stands, when cut, convert easily to stands composed predominantly of pine. With younger stands of greater sprouting vigor, only a spotty conversion will be accomplished unless the sprouts are controlled by silvicides or other weeding treatments.

Pine-scrub oak.--Compared to the oak-pine type, pine-scrub oak sites are usually drier; and bear oak--the principle oak species--provides far more competition to pine reproduction and is more difficult to control than the tree oaks. Consequently, establishment and survival of pine reproduction in this type are more precarious, and light winter fires have been less successful in increasing the stocking of pines than in oak-pine stands. Generally, fewer pine seedlings start, or drought may eliminate a large proportion if they do start. With favorable weather, prescribed burning for seedbed preparation, possibly supplemented by direct seeding and brush-hogging, can get reproduction started; but subsequent release from the scrub oak still will be needed.

Old-field pine.--Usually an understory of oaks and hickories is so well established by the time these pine stands approach maturity that burning before harvest cutting does not accomplish much hardwood control. Its chief effect is to favor establishment of pine seedlings, which then must be helped after the harvest cut by release treatments, if pines are to dominate the next generation.

If periodic winter burning were started in pine stands at an earlier age--say 15 or 20 years--and continued, that alone might sufficiently check the hardwoods to permit re-establishment of pine after harvest cuttings. This has not been demonstrated, but the possibility is being studied.

From the limited experience with prescribed fire on the Maryland Eastern Shore, periodic winter burning appears to have little place in the loblolly pine silviculture of that region. In the first place, loblolly pine seedlings grow faster from the start than pitch and shortleaf seedlings, and can become established with less seedbed preparation and less control of competitors. Furthermore, because of the high volumes in loblolly pine stands, there is much damage to advance reproduction during logging, and regenera-

tion must depend largely on seedlings that start after the cutting. However, in certain types of hardwood-pine stands with dense hardwood understories, where disking before the harvest cut seems the most practicable way to secure pine reproduction, one or two prior winter fires will reduce the volume of understory material and thereby considerably increase the efficacy of the disking treatment.

Attempts to prescribe-burn in Virginia pine stands on the Beltsville Experimental Forest have not been successful in either winter or summer. Under fuel-moisture and weather conditions considered safe for burning, the comparatively thin and compact litter of Virginia pine would not carry a fire.

Uses Of Hot Summer Fires

The pine lowland sites of New Jersey are imperfectly to very poorly drained; pitch pine is the predominant overstory tree, and dense, shrubby, highly flammable understories are common. Here light winter fires during the rotation cannot be used effectively. Yet, good results may ensue from one very hot and deep-burning fire in late summer or early fall, either just before or after a seed-tree cutting. Such a fire kills the buds of competing vegetation so that it does not resprout, and provides a favorable seedbed for pine. Lighter fires fail to do this. Fuel and weather conditions suitable for a good burn on lowland sites occur only in certain years; the fires are difficult to handle; and costs per burn may run several times higher than on upland sites.

The poorly drained sites of the Maryland Eastern Shore are somewhat like those of the New Jersey pine lowlands. Regeneration of many Eastern Shore loblolly pine stands can be greatly helped, as in the Jersey pine lowlands, by one hot and deep-burning summer fire after a seed-tree cutting.

Slash Burning After Logging

Fire for slash disposal after logging may be used in various situations where regeneration does not depend upon advance reproduction. In one New Jersey type in particular--Atlantic white cedar--clear cutting followed by slash burning is recommended practice. If the slash is burned when the peaty substratum is wet, suitable conditions for cedar regeneration are provided. Without burning, much of the area in slash will be restocked by hardwoods.

On the Maryland Eastern Shore, slash burning sometimes may be advisable as preparation for planting or for natural regeneration.

Prescribed Burning in Wildfire Control

Prescribed burning as a wildfire control measure is widely used on both public and private lands in the Jersey pine region. Its main function is to reduce the continuity and volume of fuels on and near the ground. This reduces the heat generated by wildfires, slows their rate of spread, renders them easier to suppress, and lessens the damage to growing timber. Periodic winter burning of upland sites for silvicultural purposes serves at the same time to make them much less subject to devastation by wildfires, and much of the prescribed burning that is done is regarded as a dual-purpose operation.

The degree to which wildfire hazards are reduced by prescribed burning varies a great deal with fuel and weather conditions. Timber stands are not fire-proofed by a regime of prescribed burning. But there are several notable instances on record in New Jersey where prescribed burning greatly facilitated suppression efforts and either prevented or greatly reduced fire damage in extensive tracts of timber.

OTHER RESEARCH

Vegetative Propagation of Sugar Maple Shows Promise

At our Burlington Research Center, the search for a practical means to produce large clonal progenies of sugar maple by vegetative means continues. This year it was found that cuttings rooted better in perlite or sawdust than in a mixture of sphagnum moss, peat, and sand; also, rooted cuttings overwintered better at temperatures near freezing than at either higher or lower temperatures.

At our Hopkins Experimental Forest, considerable success has been obtained in air-layering to produce roots before cuttings are made. One-inch-wide girdles for layers were 43-percent successful, and much more effective than narrower girdles. In one test of one-inch girdles on ten roadside trees, a record 67-percent success was obtained. Polyethylene and aluminum foil wraps used in air-layering gave about the same rooting success, but under the aluminum foil the roots were finer and more evenly distributed.

Control of Seedling Growth

Growing seedlings in nurseries and establishing them in plantations could be done more efficiently if dormancy and growth could be controlled better. In view of recent

research developments with various plant-growth regulators, the Warren Center in cooperation with the Pennsylvania Department of Forests and Waters is testing certain of these growth-regulator chemicals on coniferous seedlings at the Mont Alto Nursery.

During the 1959 growing season, newly germinated seedlings of white pine, Norway spruce, and Japanese larch were treated with gibberellic acid (GA). Seedlings were sprayed with various concentrations of GA up to 1,000 ppm. at 2-week intervals throughout the summer. Treated Norway spruce became chlorotic, and Japanese larch was severely injured or killed by GA. Only white pine responded favorably by showing increased height growth from all combinations of 100, 500, and 1,000 ppm. Late summer applications of maleic hydrazide caused Japanese larch to drop its needles early. This work will be continued in 1960.

Hybrid Poplar Growth Rates Correlated with Root Anatomy

For some years, workers interested in the development of apple rootstocks in England have been using anatomical criteria to select dwarfing and vigorous types. An investigation of the root anatomy of hybrid poplars has revealed that similar relationships exist between anatomy and vigor in poplars and that early selection based on these relationships could be practiced.

Roots of trees of 25 clones, 1 year old from cuttings, were used in this study. Although many features of root anatomy were investigated, bark thickness (on roots of similar diameter) appears to be the best single criterion for selection. Fast-growing clones are characterized by thin bark whereas slower-growing types have thicker bark. Highly significant correlations were obtained between the bark percent of the 1-year-old trees and the height and diameter growth of the same clones in 9-year-old plantations at Beltsville, Md., and Williamstown, Mass.

Causes of Gummosis in Black Cherry

Gum spot or gummosis, a defect found in the wood of black cherry, causes degrade in cherry veneer, particularly when the spots occur in large numbers. This year exploratory work was begun at the Warren Center to seek the cause and a means of control.

The defect seems to be caused primarily by the cambium miner Phytobia pruni. The larval channels under the bark cause gum streaks or spots in the wood. In a number of trees examined by sectioning and bark peeling, the channels

were found to begin in the small branches, lead down to the trunk, and then lead either up or down. Cross sections from the upper parts of the boles contained more gum spots than sections at breast height. Larva specimens, the first reported outside New York State, were obtained from channels in these trees and were identified.

Sodium Arsenite Paste a Promising Silvicide

Continuing research and development at our Paul Smiths Research Center on safer and more efficient ways to kill unwanted trees with sodium arsenite has led to a new and promising technique. Several sodium arsenite paste formulations have been developed and tested for the stable physical properties necessary under different conditions.

The best of these pastes have been compared with arsenite solutions for tree-killing effectiveness. Paste applied from a disposable metal or plastic tube to holes made with a special increment hammer is safe, clean, and easy to use; and the killing effectiveness is high. When used in holes spaced 4 inches apart, 0.5 cc of the paste is roughly equivalent to 2 cc of 40-percent solution (the highest solution concentration compared).

More on the Japanese Honeysuckle Problem

In 1958 certain foliage sprays were reported to have given good top kills of Japanese honeysuckle; yet some roots survived, and recovery was disconcertingly rapid. Studies in 1959 confirm this.

Some of the scattered sprouts of Japanese honeysuckle starting in plots that had been sprayed twice in 1957 with 2,4-D or a mixture of 2,4-D and 2,4,5-T grew about 25 feet in 1 year (including laterals and sublaterals of the vines) one sprout in 1 year grew from 0.9 foot to 46 feet. The honeysuckle on these plots has recovered so rapidly since treatment in 1957 that it has now regained its original density. Sprays of 2,4-D or 2,4,5-T caused more rapid top kill, but were followed by more rapid recovery than the slower acting amitrol. But in all cases the recovery was so rapid that this conclusion is incontrovertible: to establish and insure dominance of tree reproduction, almost complete elimination of the honeysuckle for several years will be required.

Since none of the initial materials gave promise of eliminating this plant pest without two or more re-treatments, ten new materials were tried this year in 21 differ-

ent formulations. It is too early to report on the effectiveness of these new chemicals at this time.

Paper Birch Regeneration

Although the turning industry--principal user of paper birch in northern New England and New York--still is finding adequate supplies of paper birch today, quality of the material has declined and sources of supply are receding rapidly into more remote areas. Moreover, since good stands of paper birch on unmanaged lands originate mostly after forest fire, improvements in forest fire prevention and control have resulted in a substantial decline in the acreage regenerating to this species.

Studies to evaluate some of the many factors influencing paper birch regeneration in the absence of fire have been begun on the Bartlett Experimental Forest. Data on first-year effects of different seedbeds showed germination and survival to be best on mineral soil. Humus seedbeds were less favorable but satisfactory. Few seedlings started on undisturbed natural seedbeds of leaf litter over humus, and mortality among these few seedlings was very high. At the end of the first growing season, 1 seedling remained on the natural seedbeds for every 8 on humus and every 46 on mineral soil. In several instances germination on a square foot of mineral soil seedbed exceeded 600 seedlings from 1,000 seeds sown.

Although mineral soil no doubt was the best medium for germination, average first-year height growth on humus seedbeds was nearly twice as great as the average for the other two seedbeds. These differences might be less pronounced during years when soil moisture conditions are less favorable than they were the past year. High seedling densities during June and July also may have contributed to the relatively slow growth on mineral soil. For all seedbeds collectively, seedling height at the end of the first growing season varied from 0.1 to 13.7 inches.

Other studies in paper birch regeneration are under way at our Bangor Research Center. On the Penobscot Experimental Forest natural regeneration after cutting of a paper birch stand is being compared on the seedbed conditions resulting from (1) winter logging on frozen ground, (2) summer logging, (3) disking after logging, and (4) burning after logging. The principal objective is to find the most economical and practicable method of regenerating paper birch after cutting. Results are not yet available.

In cooperation with the Maine Hardwood Association, eight experimental plantings of paper birch have been made on company lands. Variables under test include methods of

site preparation, methods of planting, characteristics of competing vegetation, animal repellents, and fertilizer applications.

Disking in Loblolly Pine - Hardwood Stands

Because bulldozing to prepare sites for pine regeneration on the poorly drained areas of Maryland's Eastern Shore often creates shallow ponds, a D-4 crawler tractor and heavy disk are being used for converting hardwood-pine stands to pine. However, as shown in a recent cooperative study by our New Lisbon Research Center and the Maryland Department of Forests and Parks, this method also has limitations.

In typically dense stands many of the small hardwoods and shrubs survive the treatment. Moreover, the tractor itself, not the disk, produces much of the effect. In our plots, operating the tractor with the bulldozer blade raised and without the disk eliminated 37 percent of all hardwoods 1.6 feet tall to 3.5 inches d.b.h.; single disking eliminated 44 percent, double disking 50 percent. Other effects of the disk were to reduce shrub cover, set back the hardwoods less than 3.6 feet tall, and increase the establishment of pine seedlings. However, because so many hardwoods and shrubs survive, and so many hardwood seedlings and sprouts start, the effect on competing vegetation is temporary.

Consequently, the added effects from the disk become important. After three growing seasons, with only the tractor treatment, there were 4,110 small pines per acre; on the disked plots there were twice to three times as many. And pines were in a free-to-grow position on about twice as many quadrats on the disked plots as on those treated only with the tractor.

Causes of Balsam Fir Mortality

Balsam fir is one of the most abundant softwood species in Maine. It is also one of the most difficult to manage. It is a shortlived tree, subject to decay at an early age and subject to mortality without readily discernible cause. Mortality appears to be more closely associated with age than size. This complicates the task of selecting trees to cut and leave and often results in excessive losses.

About 400 merchantable balsam fir trees of all sizes were selected at random on the Penobscot Experimental Forest in 1954 and examined annually for 5 years to determine

whether mortality was preceded by external symptoms of decadence and impending death. Approximately 23 percent of the trees died in the 5-year period. Mortality occurred in all diameter classes.

Of the trees that died, 29 percent apparently succumbed to stem attack by the balsam woolly aphid; 30 percent had severe enough butt rot to be broken by wind, 11 percent were uprooted, possibly as a result of root rots; and 30 percent died of other causes, most of them unknown. At the current rate all 400 sample trees will be dead in less than 25 years.

About 40 percent of the trees that died had gouty or dead tops caused by the balsam woolly aphid, and 68 percent had stem attack by this insect at the time of their death. Stem attack by the balsam woolly aphid obviously is a major factor in the high mortality rate of balsam fir in southern Maine. The more prevalent gout phase of this insect may account for more fir losses than was formerly recognized. It may also be the point of entrance for trunk rots, which cause considerably more cull than root- or butt-rots.

Stand Conversion in West Virginia

White pine, which once occupied an important place in the economy and ecology of West Virginia forests, has been greatly reduced by heavy early cutting and fire. The Elkins Research Center is conducting a study to determine whether white pine can be re-established in mixed pine-hardwood stands on the poorer hardwood sites.

White pine seedlings were underplanted on paired 0.3-acre plots on three poor hardwood sites. On one plot of each pair all hardwoods 4 inches d.b.h. and larger were girdled; on the companion plots the hardwood overstory was left untreated.

After 6 years, survival is high on all plots (89 to 99 percent); and no significant differences have appeared yet between sites or canopy conditions. However, the pines planted under cover are spindly and sparse-needled. Height growth of all pines on the released plots averaged 5.8 feet, whereas those under canopy averaged 2.6 feet.

Average height growth on the released plots over the last 5 years has been in inverse relation to site-index ratings for oak--4.0, 4.7, and 5.4 feet on site indexes 59, 52, and 45, respectively. This result is attributed to increasing hardwood competition with increasing site quality; that is, the competition has more than offset the direct effect of site quality on pine height growth.

On areas with oak site indexes between 40 and 50, a mixed pine-hardwood stand apparently can be established with only one release by spraying or cutting several years after planting. At site index 60, the land is capable of growing hardwood timber at a fair rate; the introduction of white pine would require several releases. It appears that the marginal site for conversion is somewhere between site index 50 and 60.

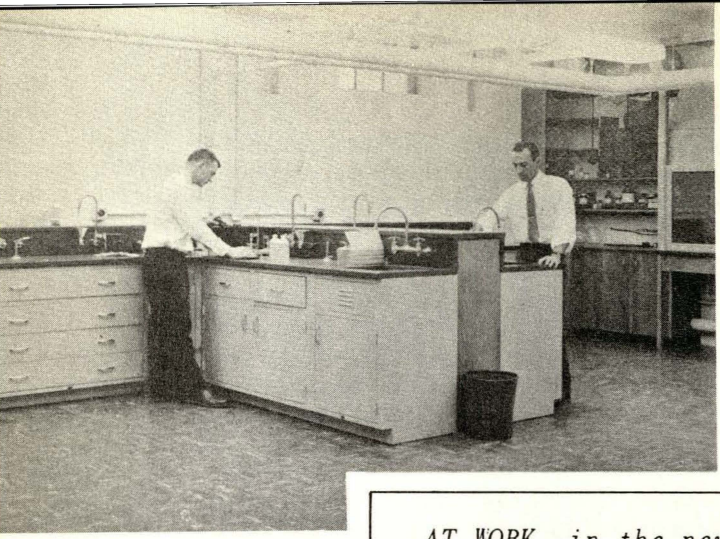
Small Woodlands Increase in Value under Management

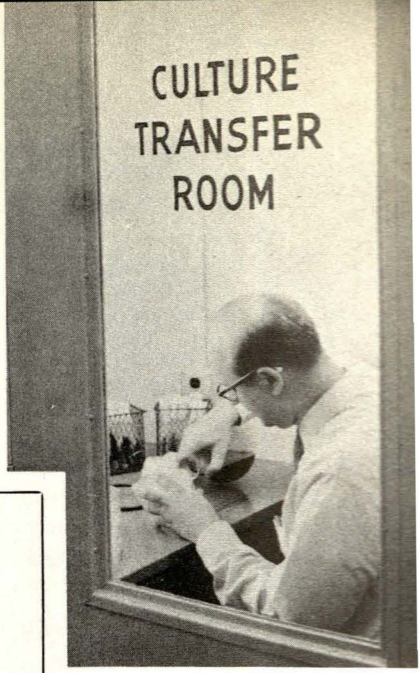
Small woodland-management units have demonstrated that by careful but practical timber cutting a significant improvement in timber quality can be accomplished in as short a time as 10 years.

On the Fernow Experimental Forest in West Virginia two small woodlands are under management, both of them on good hardwood sites that support oak stands with some intermixture of cove hardwoods. Stand conditions at the beginning of management on Woodland No. 1 were typical of heavily cut and severely burned small woodlands in the area; on Woodland No. 2 stand conditions were somewhat better. In each woodland, a volume about equal to the expected growth was cut each year for 10 years. Trees that were least likely to improve in value--because of species, quality, or vigor--were marked for cutting.

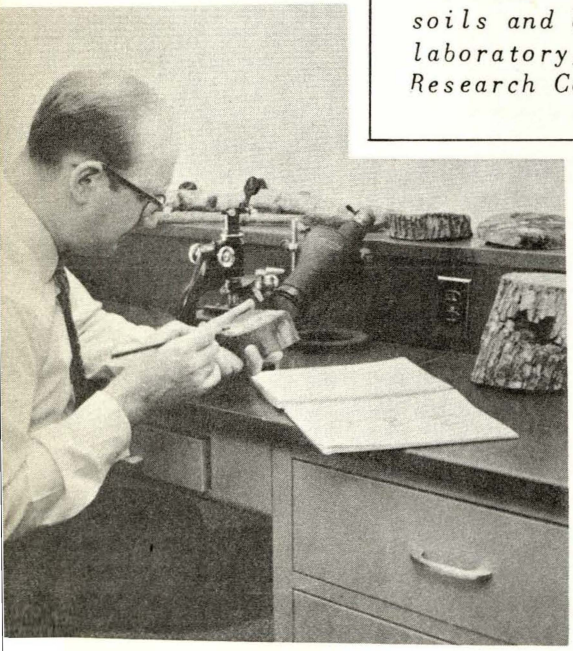
Results of the treatments have been striking. In Woodland No. 1 the percentage of stand volume in log grades 1 and 2 has increased from 17 to 43 percent; in Woodland No. 2 it has increased from 32 to 58 percent. Cull material has been reduced from an average of 8 square feet basal area per acre to less than 2 square feet. Whereas originally about two-thirds of the total sawtimber volume was in high-value species, now three-fourths is in this class.

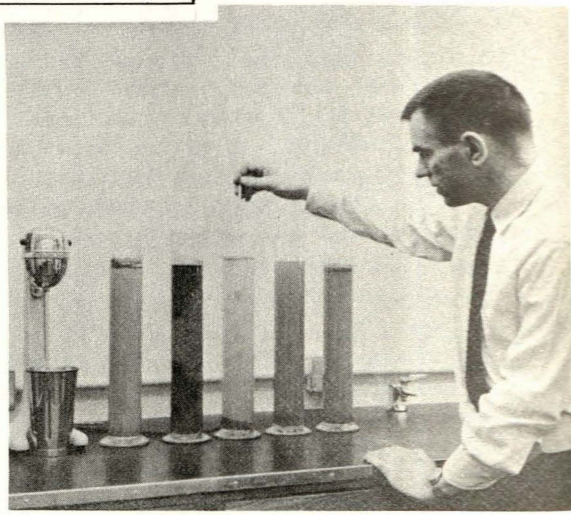
In spite of these rapid improvements in stand quality, the management practices require little or no cash investment. Instead, for an owner who hired logging done, returns from Woodland area 1 almost covered cash costs. Woodland area 2 provided some $800 above operating costs for the 10-year period.

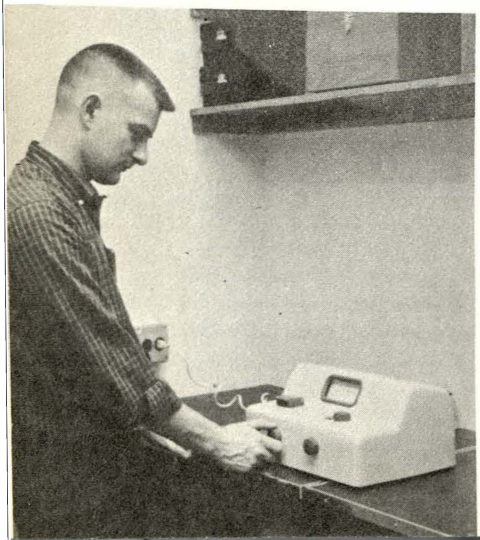


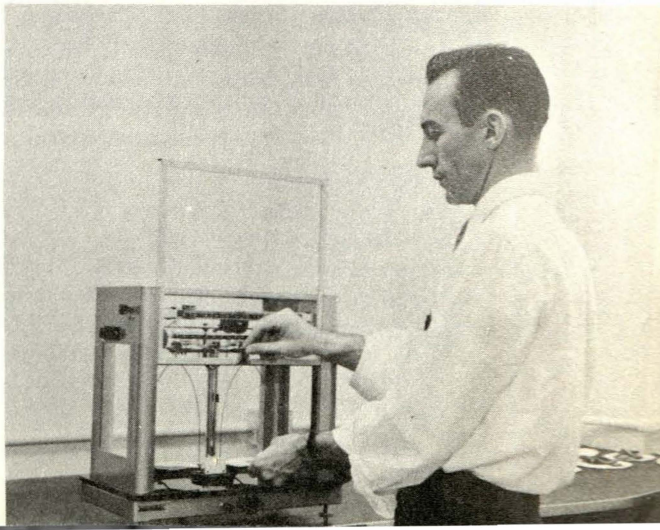


AT WORK in the new soils and biological laboratory, Laconia Research Center.









Watershed Management

WE estimate conservatively that about 1.1 million acres of forest land are logged annually in the Northeast. The logging may range from clear-cutting to make room for a new suburb to an intensive selection cutting by a conservative owner who is anxious to keep his woodland in top growing condition.

However cut, these trees have been using water, intercepting rain and snow, providing litter that forms humus, and holding the soil. Obviously cutting will affect these tree-water-soil relationships, and thereby affect streamflow; and different degrees of cutting will produce different degrees of effects. For the first time in the Northeast, these effects have been measured in a study conducted at the Fernow Experimental Forest in West Virginia by our Elkins Research Center.

Effect on Streamflow

The study began in May 1951 when precipitation and streamflow measurements were started in five small forested watersheds. Ranging in area from 38 to 96 acres, they supported a 50-year-old cover of hardwood timber that had been undisturbed for several decades. In May 1957, after a 6-year calibration period, logging started; and by December 1958 four of the watersheds had been cut over, each according to a different cutting system.

The predicted streamflow, presumed as if there had been no cutting; the actual streamflow measured in the 1959 growing season; and the difference between the two--the increase in streamflow--are given in Table 1, in area-inches.

There is an obvious and logical relationship between the degree of cutting and the increase in streamflow: the heavier the cut, the greater the increase. Streamflow from the commercially clear-cut area more than doubled for the May-October period; where less than half as much volume was removed, the increase was about one half; and where lighter selection cuts were made, the increases were still less.

Because streamflow normally is low during the summer

Table 1.--Increases in streamflow on four treated watersheds, in 1959 growing season

Streamflow	Commercial clear-cut	Diameter limit	Extensive selection	Intensive selection
July:				
Actual	0.73	0.62	0.55	0.27
Predicted	.15	.18	.37	.24
Increase	.58	.44	.18	.03
August:				
Actual	0.67	0.47	0.44	0.21
Predicted	.12	.17	.23	.18
Increase	.55	.30	.21	.03
September:				
Actual	0.17	0.13	0.11	0.04
Predicted	0.01	.03	.05	.04
Increase	.16	.10	.06	.00
October:				
Actual	1.56	0.72	0.98	0.36
Predicted	.29	.32	.40	.29
Increase	1.27	.40	.58	.07
Growing season (May-October):				
Actual	5.67	5.23	5.64	3.72
Predicted	2.59	3.39	4.22	3.41
Increase	3.08	1.84	1.42	.31
Basis: Volume removed (cut and cull) 1,000 bd.ft. per acre	9.0	4.3	3.5	1.8

months, small increases can easily double or triple monthly yields. Such increases, even though small, are most timely and useful. (An increase of 1 inch per acre in yield is equivalent to 27,154 gallons.)

Increases in streamflow from the commercially clear-cut watershed for two growing-seasons were as follows:

Period	Increase in streamflow (area-inches)	
	1958	1959
May	0.09	0.25
June	1.27	.09
July	1.60	.58
August	1.18	.55
September	.46	.16
October	.16	1.27
Growing season: May-October	4.35*	3.08*

*The six individual months do not add up to the growing season totals because the latter were computed by using independent prediction equations for the growing season.

The rapid sprout and herbaceous growth after cutting explains in part the decreasing effect; different amounts of rainfall between the two seasons are also partly responsible for yield differences.

Effect on Water Quality

Logging also affected water qualify: in this instance the effect was related to the care with which logging roads were laid out and maintained. The maximum turbidities measured were:

Type of area	Turbidity unit*
Control--no logging	15
Intensive selection with carefully planned skidroads	25
Extensive selection with planned skidraods	210
Diameter-limit cut with unplanned skidroads	5,200
Commercial clear-cut with unplanned skidroads	56,000
(Drinking water standard, maximum)	10

*Corresponds roughly to parts of soil per million parts of water.

These turbidities reflect the consideration given to skidroad location and care. They are in the same order as the area disturbed by skidroads. On the commercially clear-cut watershed with an unplanned road system, 7.1 percent of the watershed was in skidroads. The diameter-limit watershed has 6.3 percent of the area in logger's choice (unplanned) skidroads. The planned road systems on the extensive and intensive selection watersheds occupy 5.8 and 1.9 percent of their areas respectively.

Small filters, constructed of posts, stock wire, and straw and placed in streams, caught a considerable quantity of sediment that came from logger's-choice roads. Over a period of 1 year, sediment trapped amounted to an average of 70 parts of soil per million parts of water.

Clear-cutting was also accompanied by significant changes in maximum and minimum water temperatures. Average weekly maximum water temperatures during the growing season increased 8°F., and average weekly minimum temperatures during the dormant season decreased 3.5°. Also, pH, methyl orange alkalinity, and conductivity increased slightly after clear-cutting.

These, then, are the facts to date. Significant increases in streamflow have been recorded from the watershed cuttings. They have been accompanied, particularly for the more heavily cut watersheds, by significant increases in

turbidity and water temperature. Analyses have not been completed to show the effects on peak flows and low flows. Nor has there been time to analyze the data in respect to chemical effects that influence fish life. And, of course, we plan to determine the effects of the cuttings on forest management returns. Until all the facts are in, we are in no position to present final judgments. We hope to publish most of the 2-year findings this year.

RESEARCH PROGRAM

While the Fernow results were making hydrological history, watershed research at other centers progressed on several fronts. Here are some highlights.

Laconia, N.H.

The fourth weir was built at Hubbard Brook despite flood and snowstorm. Rainfall of 8.28 inches on October 23-24 produced record peak flows, severely damaged concrete forms of weir 4, filled the stilling basin of weirs 1, 2, and 3 with rock and debris, and washed out about ½ mile of road. By the time the forms were rebuilt, winter had set in, and snow fell before weir 4 was poured.

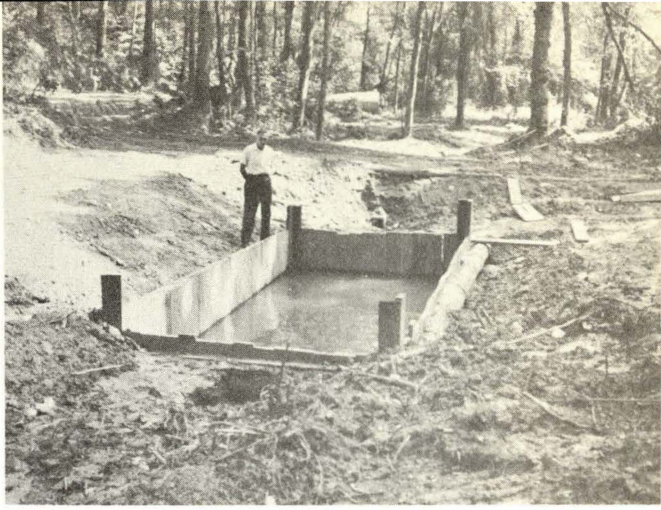
The flood-producing October storm followed a 2-week rainy period, and resultant peak flows demonstrated the small amount of storage that is available under these conditions. Instantaneous peak flows were about 470 csm.; peak flows during the previous 2 years has been about 75 csm. from rain storms and about 200 csm. from combined rain and snow melt. (1 csm = 1 cubic foot per second per square mile. For the White Mountains, runoff will average from 1 to 3 csm.)

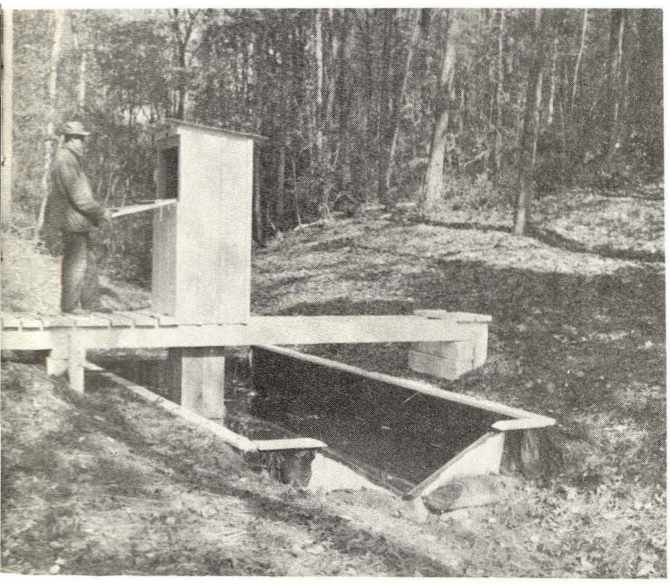
Other accomplishments at Hubbard Brook include publication of a paper describing procedures used in a soils survey of the Experimental Forest. A paper describing the effects of forest cutting on humus depth was also prepared: humus averaged 1 inch deeper on a plot clearcut in 1875 than on one clearcut the same year and again in 1939. A problem analysis and program for watershed-management research was published.

Development of sampling instruments and provisions for soil and water analyses progressed. An automatic suspended-sediment sampler, triggered by changes in water-depth of the stilling basin, was developed in cooperation with the Fernow researchers. A soils laboratory, in the basement of the Laconia office, was completed.

A 2-year study of interception and streamflow in

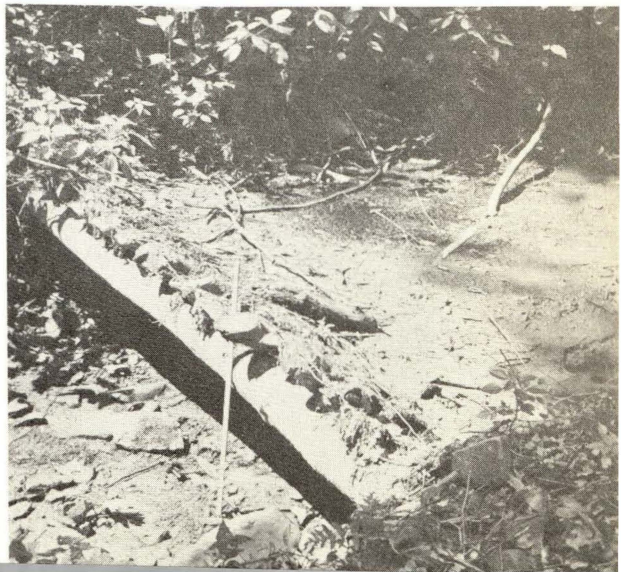
EXPERIMENTAL wooden weir under construction at Baltimore watershed. →

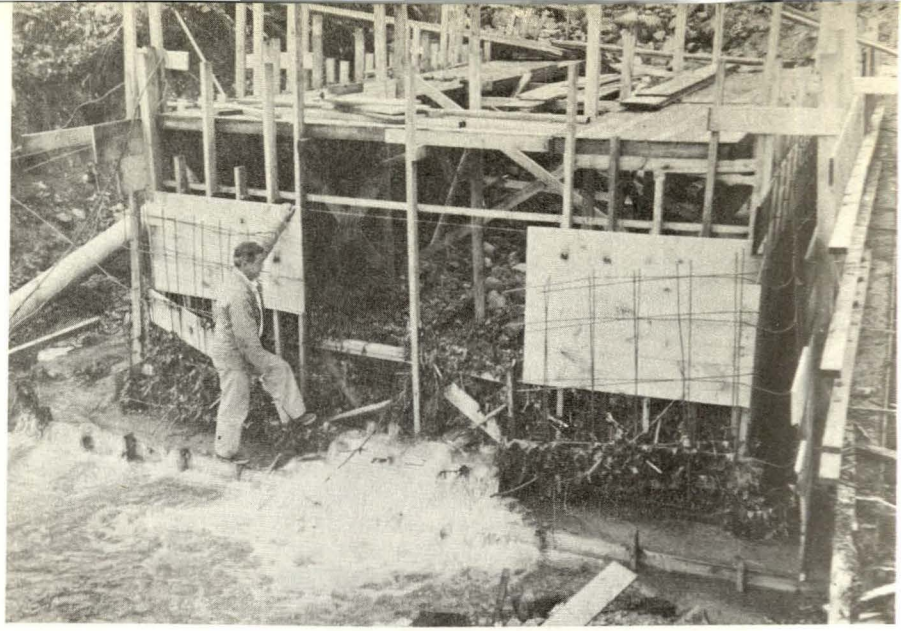




← *WEIR completed and now in operation. It has a lining of vinyl plastic.*

A SIMPLE stream filter, made of logs, wire, and straw, was used to trap sediment in studies on West Virginia watershed. →





A RECORD STORM in October delayed work on a new weir at Hubbard Brook. Debris piled up waist high in the weir forms.

HALF A MILE of road was washed out on Hubbard Brook Experimental Forest by the same storm.

northern hardwoods was completed, and a study was begun of snow accumulation and melt and frost in red and white pine plantations, northern hardwoods, and on open areas.

New Lisbon, N.J.

Transfer of the watershed-management research project from Kingston, Pa., to New Lisbon, N. J., brought together under one project studies on the Dilldown and Pocono watersheds, and the cooperative watershed studies with Baltimore, Md., Newark, N. J., and at State College, Pa., with the School of Forestry of The Pennsylvania State University and the Pennsylvania Department of Forests and Waters.

Gaging was started on the three Newark weirs in April, and Baltimore built a third weir and started gaging in October. The Baltimore weir was experimental, consisting of a wood-sided stilling basin covered with vinyl plastic. Two ground-water wells and recorders were added to the instrument network at State College.

A study of comparative water use of shortleaf and pitch pine overstory and its vaccinaceous understory was started at the Lebanon Experimental Forest. After initial comparisons have been made, the effects of foliage-density changes on water use will be determined.

Paul Smiths, N.Y.

During the winter of 1958-59, snow accumulation and melt were measured in conifer and hardwood sapling and sawtimber stands and in several cutover stands ranging from commercial clear-cutting to light selection cutting. At time of maximum snow accumulation (March 16, when average snow depth was 34 inches and its water content about 8 inches) hardwood sapling and sawtimber stands contained two more inches of water than those in balsam fir and red spruce stands.

Snow melted in the hardwood stands in 34 days but required 43 to 50 days in the conifer stands. Accumulation and melt in the cutover mixed hardwood and conifer stands were intermediate. Average accumulation and melt values by snow courses were correlated with canopy closure as measured with a densiometer, and canopy closure in turn, appeared to be correlated to the summation of d.b.h.-inches per acre.

Bangor, Me.

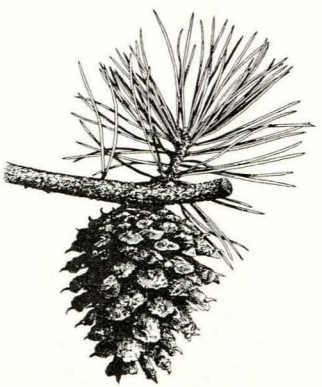
A summer's measurement of soil-moisture in a mixed pine-fir-spruce stand near Orono, Maine, revealed unfavor-

able moisture conditions and the influence of the hump-and-hollow topography. A perched water table maintained poor aeration conditions, even with low rainfall, until July 1. As soon as the water table dropped below the shallow root zone, there was little water available for growth. Moisture content of soil in hummocks dropped below saturation 1 to 2 weeks before this drop occurred in hollows.

Regional

Humus depth in virgin stands was studied region-wide. A survey of 18 virgin stands revealed that humus ranged from 8 to 16 inches deep in spruce-fir stands, from 3 to 9 inches under hemlock and hardwoods in the Adirondacks, and from 2 to 5 inches elsewhere in the Northeast.

Present-day sapling and sawtimber hardwood stands had an average humus depth about 1 inch shallower than virgin hardwood stands; young-growth hardwood stands had about 3 inches less humus. Considering that 1 inch of humus can store 0.8 inches of water (0.4 inch retention and 0.4 detention), and that about one-third of the Northeastern forest area is occupied by young growth (some 21,000,000 acres)--the relevance to flood protection is obvious.



Forest Insects

RATHER than attempt a comprehensive summary of the status of destructive forest insects in the Northeast or the overall research program of the Division, we will highlight some relatively new and important lines of study now under way at the Northeastern Station.

In some cases, our findings are very preliminary and are still more in the class of hopes or exciting prospects than tangible accomplishments. In others, some immediate applications are apparent and demonstrate once again that basic research is not necessarily far-fetched or impractical.

The tackling of these new problems has been made possible by the improvement of laboratory facilities, acquisition of new equipment, and staffing of technical personnel at the New Haven Laboratory; and by a new insectary at the Laurel (Md.) Research Center and increased use of the facilities of the nearby Agricultural Research Center.

INSECT CONTROL BY MEANS OTHER THAN INSECTICIDES

It is quite possible and feasible to control destructive insects without killing them outright with toxic chemicals. It can be done by using: (1) microbial agents, principally viruses and bacteria; (2) genetic means, such as the release of irradiated sterile males into local populations; and (3) anti-metabolites and hormones. The latter are naturally or synthetically derived chemicals that are non-toxic in the sense that they do not kill the insect by direct action on vital tissues; they simply disrupt or stop the metabolic processes or functioning of the insect so that it fails to complete development.

Each of these methods has one or more of the following advantages over the insecticidal method: (1) specificity --acting on just one species, and, possibly, its immediate relatives; (2) carry-over effects--continued and sometimes intensified mortality in successive generations; (3) no harmful effects on fish and wildlife, beneficial insects, or plants; (4) less expensive, especially on a long term basis.

With the possible exception of bacterial sprays, all have the disadvantage of being slower acting, thus suggesting application before the insect population builds up to damaging levels. At present these methods are viewed as possible supplementary measures to chemical control, not necessarily replacement of it. However, proper development and use of them no doubt will decrease the call for emergency control action with insecticides, particularly on a large scale.

Microbial Agents

At the New Haven Laboratory, approximately 200 isolations of microorganisms from diseased forest insects were made in 1959, and these are now being identified. Most of the material involves caterpillars (such as the orange-striped oak worm, forest tent caterpillar, gypsy moth, and spiny elm caterpillar) and sawflies (including the European pine sawfly, red-headed pine sawfly, and Virginia pine sawfly). Some diseased stock has been obtained from gypsy moths collected in Japan. The general collections were made both by Station personnel and cooperators. This exploratory survey is a continuing project, with the establishment of an identification and storage bank at New Haven as the first step. Pathogenicity tests will be made of all organisms showing any promise of use in applied control.

A serological study of the gypsy moth wilt disease, which is caused by a polyhedral virus, was conducted as a cooperative project by the bacteriology department of the University of Connecticut. Certain findings had practical significance:

- Relatively high titre antisera can be developed in rabbits for both the polyhedral bodies and the free virus of the disease.
- A simple precipitin test is feasible for laboratory and field determinations of the disease organism before visible symptoms appear.
- The virus was found in feces of infected larvae, indicating one way in which the disease is carried over from year to year.

Some quantitative aspects of this serological technique are being investigated further. The technique will be a valuable tool for developing gypsy moth and other insect viruses for control purposes. And--equally important--it will mean one more step toward better biological appraisals of forest insect infestations.

Some useful preliminary information was obtained from small-scale tests of the polyhedral virus and Bacillus

sotto, a spore-forming bacterium that may be useful against the gypsy moth. This bacterium has proved effective against a variety of agricultural insects and is now available commercially. The tests showed that either B. sotto or its diatomaceous earth carrier repelled young gypsy moth larvae. The insects refused to feed on foliage sprayed with it.

Now there is the problem of finding satisfactory carriers as well as determining optimal dosages for these microbial sprays. The B. sotto sprays in concentrations of 25, 50, and 100 million spores/ml. did not give satisfactory control in the laboratory, but the mortality effected did increase with the higher concentrations. The tests indicated that for the virus a dosage of at least 10 million polyhedra/ml. or 100 billion polyhedra to $2\frac{1}{2}$ gallons of water would be needed for control in the field. The polyhedrosis can be detected by dissection of the larvae about 10 days after exposure to the virus spray.

A field test in Connecticut of a closely related bacterium, Bacillus thuringiensis, applied by airplane at the rate of 16 billion spores in $3\frac{1}{2}$ gallons of water per acre against first-stage gypsy moth larvae, was unsatisfactory.

A survey was made of current forest tent caterpillar infestations in southern Pennsylvania. Oaks, maples, and aspen were severely defoliated over a wide area in Somerset and Fayette Counties, evidence of very high larval populations. Yet in this area very few cocoons were found and large masses of diseased larvae were noted throughout the affected stands--a vivid demonstration of what a virulent disease can do to a threatening insect population.

Eastward, from Mont Alto to Boiling Springs, heavy stripping of trees occurred with little or no evidence of disease. Here several blocks have been set up for the field testing of a virus spray against the forest tent caterpillar, using eastern tent caterpillar virus supplied by the Insect Pathology Laboratory at Beltsville. Laboratory tests have indicated that the viruses of the two insects are equally pathogenic against the other.

A stock of European pine sawfly virus was processed at the New Haven Laboratory for control applications by the Pennsylvania Department of Forests and Waters. About 250 acres of red pine under attack by this insect were treated with very satisfactory results. A 2-acre Christmas tree planting was sprayed successfully in Connecticut. The recommended dosage of 5 billion polyhedra in 2 gallons of water per acre applied in the early spring about the time of egg hatch has proved reliable on a number of operations. The method is particularly enticing because the supply of next year's virus stock is obtained from the diseased insects in

the area treated. Limited tests in the laboratory and field have indicated that the European pine sawfly virus will also kill some other closely related sawflies.

A checkup this year in the Beltsville Experimental Forest areas sprayed with virus by helicopter in 1958 for control of the Virginia pine sawfly failed to yield any evidence of virus. Larvae from field-collected eggs of the 1958 generation exposed to the treatment developed normally in the laboratory. A large number of larvae collected in the spring of 1959 were placed on trees that had been treated the previous year. All developed normally. Apparently this is one insect virus that does not carry over readily from one year to the next.

Genetic Control

Gamma Radiation

The experimental treatment of gypsy moth pupae to produce sterile males was continued in 1959. Two series were exposed to specified dosages from a radioactive cobalt source at the Brookhaven National Laboratory. Older pupae were irradiated to obtain maximum effects on the sperm-producing cells or sperm and minimum injury to the body tissues.

In contrast to the 1958 experiment, very few adult cripples resulted from the treatments. The reciprocal matings of treated and untreated males and females were carried out successfully, and all eggs laid are now in cold storage at the New Haven Laboratory. We do not know as yet which lots, if any, are non-viable.

Gypsy Moth Intersexes

The gypsy moth presents a unique opportunity for genetic control by yet another means. Studies in the early part of the century by Robert Goldschmidt revealed that the various races of this cosmopolitan insect throughout Europe and Asia differed in the potency of sex-determining factors, so that intersexual forms resulted from certain crosses. Crossing males of a "strong" race (found only in Honshu, Japan) with females of a "weak" race (such as the American strain) produces normal male offspring and intersexual females that are sterile. Moreover, when the hybrid males in turn mate with normal females, sterility results in one-half the female offspring.

The problem of developing this phenomenon into a practical control method is largely one of mechanics and logistics: obtaining the necessary stock of "strong" males from Japan, rearing these in sufficient numbers, and re-

leasing them at the right time and place to compete successfully with the local male moths. Female gypsy moths mate only once and do not fly, thus the introduced males must be just as responsive to the female attractant as the local buckos.

A preliminary step has been taken at the New Haven Laboratory by crossing a small number of Japanese male moths with females of central European origin. The matings were successful, and the eggs produced are in cold storage. It is not known whether these Japanese males represent a "strong" race, but dissection and crossing of the F_1 hybrid females will give the answer. It is hoped that this line of study can be developed further.

Anti-Metabolites and Hormones

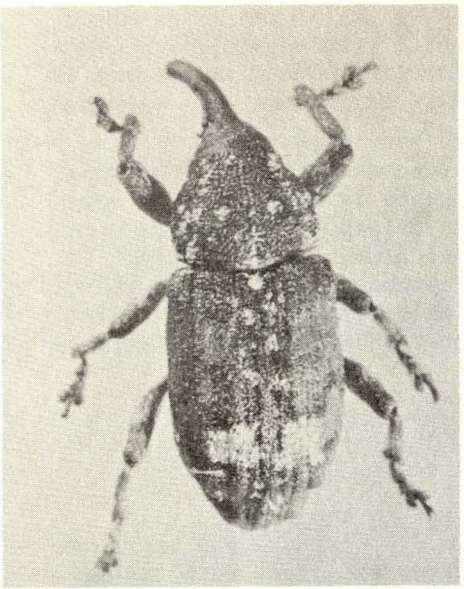
We do not have the facilities or staff for basic research along this line. However, in cooperation with the Entomology Research Division, A.R.S., a test was initiated with juvenile hormone extracts from the gypsy moth and the cecropia moth. Both extracts are scarce. The effectiveness of each in preventing development of gypsy moth larvae and pupae will be determined. The test insects are now in rearing at New Haven.

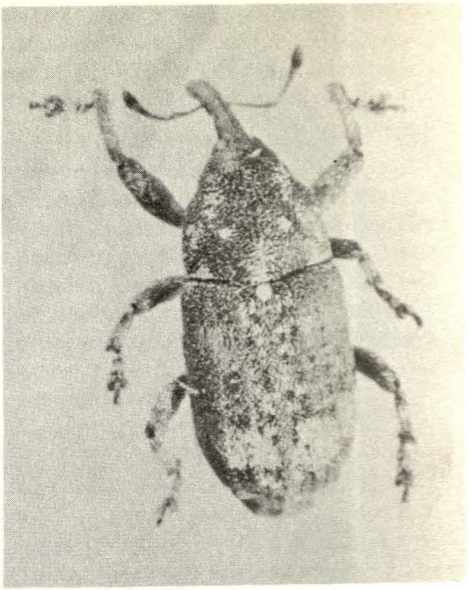
WHAT INSECT IS THIS, ANYWAY?

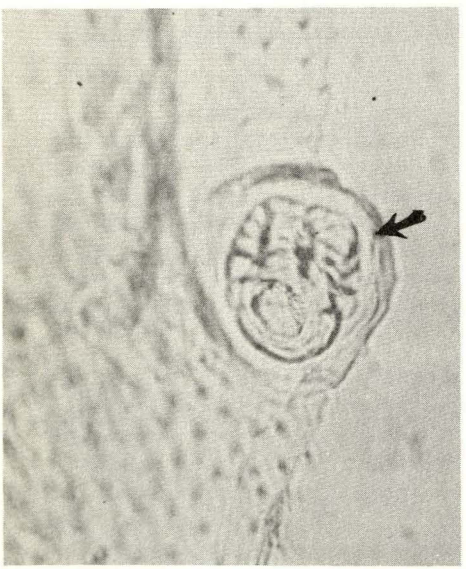
Insect taxonomists are a flighty lot: they're always changing the names of insects we know perfectly well or grouping several seemingly quite different ones into a single species. Some of our most common pests are still being untangled taxonomically. The taxonomists have their problem.

For example, you might think that after all these years we would know a white-pine weevil (Pissodes strobi) when we saw one. But we have a real ringer now appearing frequently on the scene: the pine weevil Pissodes approximatus, which is morphologically indistinguishable from P. strobi, at least as an adult beetle. The finding that the two "species" will mate and produce viable offspring in the laboratory indicates that further checking is needed.

The characteristic damage that P. strobi does to leaders of healthy white pines and other host trees is a common enough sight throughout the Northeast. P. approximatus attacks weakened and dying red pine and other conifers; eggs are laid and larval broods develop in the lower stems. But now we know that P. strobi will lay eggs and complete its life cycle in the stems of mechanically weakened red pines; and P. approximatus can be forced to attack







QUESTION: Which of these two insects is the white-pine weevil, Pissodes strobi? *Answer: The one at upper left. The insect at upper right is the ringer,* Pissodes approximatus. *Photomicrographs show (lower left) the darkened sclerone around spiracle of 4th-stage larva, which is supposed to distinguish the white-pine weevil from its double.*

and develop successfully in white pine leaders. The crux of the problem: are these insects truly isolated reproductively under natural conditions?

Experimental crosses of strobi from white pine leaders collected in central New York and approximatus from girdled red pines near New Haven produced viable offspring in all cases. No sexual incompatibility was observed, and there were no significant differences in the number of eggs laid. Some quantitative differences occurred in the viability of the eggs and the number of progeny completing development to the adult stage, with eggs from the approximatus ♂ X strobi ♀ cross being least viable and the strobi females producing fewer F1 adults than the approximatus females. The F_1 adults were then mated and also backcrossed with strobi and approximatus reared from the original parent stocks. These have now all produced viable offspring, thus eliminating hybrid sterility as the isolating mechanism. It now remains to determine the ecological isolating mechanism in the field.

If these two weevils prove to be not isolated reproductively, with some interbreeding occurring, then the present policies and methods of controlling P. strobi are due for a re-assessment. For the application of toxicants to tree leaders or the removal of infested leaders would allow a continued reservoir of insects in the form of the approximatus population. Some apparent inconsistencies in past experimental and practical control operations against P. strobi and the rapid buildup of populations in treated areas might be due to this reservoir effect.

WHAT MAKES SAMMY RUN?

The primary activities of insects--feeding, mating, egg-laying, dispersal (flight), hibernation--are closely geared to the physical factors of the environment. Light, temperature, humidity, air movement, and even the changing length of day directly and indirectly influence the insects' behavior, development, and ultimate survival. Moreover, the air-mass climatology and periodicity of climatic changes play a key role in the development of outbreaks of some of our most destructive pests.

To the forester, these interrelations are of interest because they determine to a large extent the kind and amount of damage to the forest by insects, and because they provide some insight into the problem of minimizing insect-caused losses by the manipulation of forest stands. Much research in insect behavior and bioclimatology is needed to provide proper basis for this. At present, we have made only the

barest beginning. Two current studies involve consideration of some of the factors mentioned above.

In connection with a detailed investigation of the white-pine cone beetle, temperature-measuring and recording instruments were installed in pine cones under a variety of conditions at the Saltonstall experimental area near New Haven. We wanted to know first the temperature regimes of the cones on the ground, in which the beetles overwinter, and the relation between temperature and the time and rate of emergence.

It was found that the maximum daytime temperature of cones in the open (exposed to direct sunlight) averaged considerably higher than cones in the shade beneath the trees, as might be expected. However, the nighttime temperatures of the shaded cones were significantly higher than of the cones in the open. For example, from April 25 to May 2 (in the general period of beetle emergence) at 12: 30 p.m the average temperature of the cones in the open was 70.6°F., while the cones under cover averaged 57.7°F. At 12:30 a.m., the cones in the open averaged 39.0°F., as compared with 47.3°F. for the shaded cones. The latter cones reached their maximum daytime temperatures 1.5 hours later than the exposed cones.

Beetle emergence followed the same pattern--the peak of emergence from the exposed cones occurred on April 25 and from the shaded cones on May 6. Emergence from the exposed cones continued to about May 8, while beetles straggled from the shaded cones as late as May 20.

A study completed this year of factors that affect parasitization of the spruce budworm by Apanteles and Glypta revealed significant differences in the host-searching and egg-laying behavior of the parasites and a marked difference in the light reactions of healthy and parasitized budworms. These two particular parasites attack the budworm larva soon after it hatches from the egg, and thus are among the first in the sequence of mortality factors acting on budworm larval populations.

Apanteles proved the more efficient when searching for and laying eggs in the motile first-stage budworms before they settled in their winter tent (hibernaculum); whereas Glypta was more efficient when attacking the immobilized host larvae in the hibernacula. As weather and micrometeorological factors strongly affect the amount and duration of movement of the budworm following egg hatch, it is apparent that these factors will influence the degree of parasitization by Apanteles and Glypta.

Second-instar budworm larvae (the stage in which they

emerge from hibernation in the spring) affected by either Apanteles or Glypta reacted negatively or not at all to a discrete light source, in contrast to the strongly photopositive behavior of non-parasitized individuals. It was shown that many parasitized larvae thus fail to come to the vials of emergence boxes (the standard method used to obtain budworms from field-collected samples of overwintering populations). Also, it was postulated that a disproportionate number of parasitized and non-parasitized budworms were lost in the early spring due to dispersal, predators, and other factors; and that the more active and light-directed healthy budworms suffered the greater loss. Moreover, the parasitized larvae were found to emerge from hibernation 7 to 10 days later than the non-parasitized, a differential response to temperature. This sort of information is necessary for both measuring and interpreting changes in budworm population numbers and the factors that cause them.

GENERAL STUDIES

The program of research at the New Haven Laboratory included a continuation of the gypsy moth rearing experiment, serological study of Pissodes spp., white-pine cone beetle life history study, biological control of the balsam woolly aphid on the Penobscot Experimental Forest by use of an imported predaceous beetle (Laricobius ericksonii), laboratory and field tests of insecticides against the white-pine weevil, screening tests of candidate repellents against the smaller European elm bark beetle, and an appraisal study of balsam woolly aphid damage by color aerial photography.

At the Laurel Research Center, other studies were conducted on chemical control of the Nantucket pine tip moth and the effect of tip moth control on the growth and form of planted loblolly pines, chemical control of the European pine shoot moth, the effectiveness of dieldrin in the glue line of oak plywood panels for protection against lyctus beetles, and the biology and control of the old house borer.

Active assistance was again extended to cooperating state and federal agencies in surveys and biological appraisals of various forest insect infestations. The most intensive appraisals were made of the spruce budworm in Maine and the pitch pine sawfly and Virginia pine sawfly in New Jersey and Maryland respectively.

Forest Diseases

Surveys

EACH year we conduct an extensive survey to evaluate the importance of forest diseases and to study the behavior of the more threatening diseases. Our pathologists make field inspections in selected areas, but the greatest amount of information is received in reports from state and university pathologists throughout the region. Our forest-disease surveys reveal where research is urgently needed and where control efforts are most justified.

Our surveys in 1959 revealed that early-season Dutch elm disease symptoms were generally severe and widespread. Foliage diseases were inconspicuous until late in the season, when they appeared in small amounts. Damage by them was negligible. Most canker and stem diseases were less evident than usual. Rusts were also lighter than usual. Leaf cast diseases were generally light, except for Rhabdocline and Adelopus needle casts of Douglas-fir, which were generally heavy. Root rots were active and damaging, especially those caused by Fomes annosus and Polyporus schweinitzii.

Conifers, especially the evergreen broadleaf species, suffered from extensive winter injury. This was caused by the intense cold of the previous winter, during which time the soils over much of the region were frozen deep and hard for several months. Many shallow-rooted conifers could not replenish moisture lost through transpiration, and foliage was killed.

Weather conditions are known to have a decided effect on many diseases and also on the expression of disease symptoms on infected trees; so each year we study the weather conditions in the region to see if we can relate weather to observed disease behavior. Weather conditions from May through the growing season of 1959 were generally favorable for good tree health and unfavorable for abundant fruiting of many fungi. The Boletes did not fruit abundantly until after September 24. Of the Hydnaceous fungi, only Steccher-

inum septentrionale was abundant last year. Most of the Polypores fruited normally. Fomes applanatus and Polyporus squamosus sporophores were above average in abundance.

Observations made in New England indicated that sugar maple dieback was less than usual. It was especially noticeable in previous years, and many affected trees died during 1957 and 1958.

Nursery Diseases

One of our pathologists visited several forest tree nurseries in which disease losses had become unusually severe. Several nurseries in Vermont and Pennsylvania have a serious problem due to root rot. Spread and intensification of this root rot could impair production schedules in affected nurseries. No research was initiated on the problem; we are not certain that the rot is the same in all nurseries, nor are we sure whether death of seedlings is the primary or the secondary result of the disease.

Our limited survey indicates that more tree species and more nurseries are being involved than in previous years. Losses seem to be increasing. Similar nursery disease outbreaks have been controlled successfully by use of soil fumigants in southern nurseries. Nurserymen in the Northeast will test these methods and we will observe results.

Nursery tree production has increased rapidly in the Northeast in recent years. State-owned nurseries in the region produced some 75 million forest tree seedlings in 1959. Increased demand for tree seedlings has caused some nurseries to disrupt their seedbed rotation schedules and many have developed new lands for conversion to seedbeds. Both of these practices increase the likelihood of losses from disease. Damping-off, sunscald, and nutrient deficiencies have been reported in many nurseries.

Plantation Diseases

Our spray control tests on the Rhabdocline and Adelopus needle cast diseases of Douglas-fir Christmas tree plantings have been disappointing. Bordeaux mixture, lime-sulfur, Ferbam, Cyprex, Actidione preparation and an experimental mercurial compound applied in 1959 did not prove effective.

The problem is complicated by the interactions of more than one disease. Rhabdocline and Adelopus needle casts are the most serious diseases in the Douglas-fir plantings and have been found in nurseries. Adelopus is very serious in Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and eastern New York. Rhabdocline

is most severe in New York; but it has also damaged plantations in Pennsylvania, Connecticut, Vermont, and western Massachusetts. Wherever one or both of these diseases are present in quantity, the weakened trees are often attacked and killed by the root-rot fungus Armillaria mellea. We are studying the host parasite relations, life histories of the fungi, and morphological relations of the parasites. A shift in emphasis from the search for a protective fungicide to attempt to find an effective eradicant fungicide is planned. We are also searching for trees that show evidence of disease resistance.

Other diseases in young plantations occur but seldom are as damaging as those mentioned above. Other problems appear in older plantations and may become very damaging in crowded, stagnant plantings.

Oak Decline

This disease, formerly called oak mortality or oak dieback, was more severe in central Pennsylvania than during the previous 2 years. Our limited aerial survey of the north-central and central parts of the state located a number of unreported disease areas. Some of these spots contained only a few affected trees, others a thousand or more. Scarlet oak was affected most. Some red oak was dying in a few of the areas. Dominant and codominant trees of 60 to 80 years old were most commonly affected, but an occasional suppressed tree was seen with the disease.

Our research this year was aimed primarily to determine possible association of oak decline with previous insect defoliation and attacks by the Agrilus borer. A study was also made of tree root systems in diseased and healthy areas. Although results obtained were inconclusive, they were adequate to justify a continuance of the research for another year. Continued search failed to reveal that a pathogenic organism is solely responsible for the decline.

Oak Wilt Control

A study to evaluate the effectiveness of two different methods for controlling oak wilt, begun in 1958, was continued. Last summer the Station established 28 study plots in Pennsylvania; 33 in West Virginia; and 17 in Maryland. Those in Pennsylvania and West Virginia received the control treatments in use in those respective states. The plots in Maryland were not treated and will serve as a gage of the effectiveness of control methods. Another series of plots is to be established in 1960. We do not expect significant results from this study in less then 5 years.

Sweetgum Blight

We established a number of plots in the Maryland-Delaware area to observe the behavior of this disease. We made a detailed examination of the crown condition of all sweetgums and other hardwoods on a 33-acre compartment at Beltsville, Md. Nearly half of the sweetgums, all growing on sites unaffected by influences such as highways, drainage ditches, habitations, and similar disturbances, exhibited typical blight symptoms. Relatively few of the associated hardwoods had crown deficiencies, more than 90 percent of them having sound, healthy crowns.

Chestnut Blight Studies

For several years our Laurel Research Center has conducted a search for surviving old American chestnut trees possessing blight resistance. About a hundred old trees have been reported to the Center by various individuals in the Northeast. The existence of these trees does not necessarily mean that they are disease resistant--they could be mere chance escapees from infection.

Disease resistance is being tested by taking scionwood from the old trees and grafting it onto young chestnut root stock. These grafted trees are outplanted and exposed to natural infection at numerous locations. We plan to inoculate the chestnut blight fungus into strains that consistently remain free of disease, as a further test for disease resistance. About 50 cooperators assist in grafting and planting trees. Only 13.5 percent of the grafts made in 1959 were successful. Many cooperators believe that the poorer results obtained this year was due to unusually dry weather during a critical part of May.

Root Rots

The most important root rot of forest trees in the Northeast, our surveys showed, is caused by Fomes annosus. It is largely a plantation problem. To study this disease, the Station established several experimental plot areas in 1956 and 1957. At that time, some of the plots were free of the disease. Now the disease is present and active in all areas. Our latest inspection, made in mid-October, showed a great increase of F. annosus infections during the year.

Rate of spread was studied on two severe F. annosus infection centers in a red pine plantation. The infection centers were 8 and 10 years old, and the focal point of each was known. The annual rate of radial spread was calculated at 5.4 feet for the 10-year-old infection and 6.8 feet for

FOMES ANNOSUS produced the unusual bracket-like sporophores on this red pine stump. The typical fruiting body of this fungus is at or slightly below the duff surface, as at left.

SURFACE FRUITING of Fomes annosus. This jumbled mass of fungus tissue, growing around a goldenrod stem, has features of both the typical form and the bracket-like form (darker surfaces). Note pine needles embedded in the fungus tissue.

the 8-year-old infection. These rates may be higher than average because the deterioration in this stand was worse than usual, the affected species was the very susceptible red pine, and all conditions seemed very favorable for the rapid spread of the disease. British workers have cited 2 to 4 feet as the rate of spread per year, but they did not specify site conditions and hosts.

Localized spread of Fomes annosus, pathologists in general agree, does not occur unless continuous woody material is present in the soil. Our observations this year cast some doubt upon this supposition. We have evidence that under some circumstances spread through duff may occur. But it does not follow that this is a common or important method of localized spread.

In one of our study plots we found an abundance of Fomes annosus fruiting on the duff surface. Such an abundance of these surface resupinate fruiting bodies had never been observed before. There were 45 such fruiting bodies within an area of 144 square feet. Nine others occurred just outside the 144-square-foot area, making 54 fruiting bodies within a very limited area. There were five stumps and two dead standing red pines within the 144-square-foot area. The surfacr fruiting structures showed no pattern of relationship to any stump or standing dead tree. Only about 5 percent of the fruiting structures showed signs of being connected with pine roots. The more distant of these fruiting bodies were about 17 feet from the nearest dead tree and even farther from any of the stumps.

The fruiting bodies in the duff had the tissue irregularities common to abnormal conks and also contained the confused and jumbled poroid layers often found in some Trametes sp. In many respects they were about halfway between resupinate Poria-like conks and abnormal fruiting pustules. Debris and duff material and various stems of living and dead weeds were commonly embedded in the structures.

Careful examination and dissection of the duff-surface fruits of F. annosus yielded no definite information on the main substrata utilized by the fungus. It seemed in some cases to be saprophytic on red pine bark fragments; on red pine twigs in the duff litter; and on dead branches of wild cherry lying on the ground; and only occasionally were the dissected masses interpreted as being parasitic or saprophytic on red pine roots still attached to stumps or standing dead trees.

A peg-like appendage was present on the under-surface of about half the fruiting masses. These pegs penetrated the duff layer as much as 3 inches (but mostly less), no

well-defined connection with a source of nutrition could be found.

The Station is conducting no research on root rots of mature trees. Yet two very important root rots need to be investigated: those caused by Armillaria mellea and Polyporus schweinitzii. Both are damaging to mature forest trees under special circumstances, and both have been encountered in work in plantation diseases. Polyporus schweinitzii was found to cause severe damage to a 20-30-year-old larch plantation. Larch may be very prone to attack by this fungus and is expected to become a greater plantation problem in the future.

Heart Rots

To the timber cruiser, one of the most confounding problems is the great volume of undetected rot in standing trees. The extent of rot associated with some fungus conks is known, but exact information on many of the wood-rotting fungi is not yet available.

Our New Haven Laboratory began studies in 1957 to gain more information about the behavior of the principal rots of our major timber species. A representative series of hardwood and conifer trees are being inoculated with pure cultures of common rot-producing fungi. These trees are to be examined periodically, and groups will be cut, dissected, and studied at intervals of 5, 10, and 15 years after inoculation. Measurement of rot progress and observations on the presence or absence of fruiting will form a basis for evaluating rot cull in living trees. It is believed that this study will provide means by which we can more accurately estimate cull in relation to fruit bodies and other external indicators.

So far a total of 525 inoculations, one to a tree, have been made; 273 of these were on the Kane Experimental Forest near Kane, Pa., and 252 were on the Hubbard Brook Experimental Forest at West Thornton, N. H. These figures include sterile inoculation checks to test the method.

Careful examination of inoculations made a year ago showed that frost cracks commonly occurred above and below the point of inoculation on the sugar maple trees at Kane, Pa. This was not observed on sugar maples inoculated at the Hubbard Brook area, nor were other species so affected. We do not know the significance of these cracks. American beech at both areas had developed sunken lesions 2 to 3 inches in diameter at the inoculation site. A few of the inoculation chambers were opened up. In all cases the fungus was growing luxuriously. The extent of growth penetration into the host tissues was not investigated. Future plans

include experimental inoculations of white pine, red spruce, eastern hemlock, and white birch.

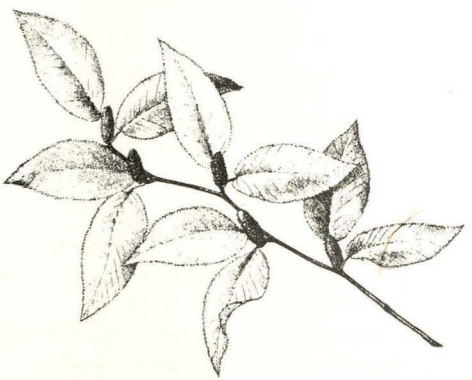
Decay After Glaze Damage

During the summer, 25 black cherry trees and several birch and beech trees that had suffered severe top breakage in the ice storms of March 1936 and February 1950 near Kane, Pa., were cut and dissected. The rots that entered through the storm breakage were measured and cultures were made from the rotted wood. The fungus cultures are now being identified. A report of results is being prepared.

Decay of Wood in Use

Seasonal wood-moisture readings in the crawl spaces of basementless houses for a number of years have shown consistently that summer (July, August, September) is the most critical period. Beginning in early July 1959, and for 12 consecutive weeks after, wood moisture, air temperature, and relative humidity were measured in the crawl spaces of six dwellings, each having a different ground cover, but all located in the same housing project near Washington, D. C.

Preliminary analysis of the data shows a correlation between the weekly average outdoor relative humidity and the wood-moisture in the crawl-space timbers. The effectiveness of the six ground covers as moisture-barriers from most efficient to the least, is as follows: (1) asbestos felt, 35-pound, 90 percent coverage; (2) linoleum; (3) asphalt-laminated paper; (4) polyethylene, 0.004 inch; (5) asphalt soap emulsion; and (6) unmounted aluminum foil, 0.002 inch, 50 percent coverage. All six ground covers were effective. The difference between the best and poorest did not exceed 3 percent in wood-moisture readings.



Forest Economics

PRODUCTION AND MARKETING RESEARCH

WHICH white pine stands should be protected from blister rust? Would Farmer A be better off to thin his northern hardwood stands, prune his pine, or plant trees on his idle acres? Cull trees are retarding the growth of many stands; but in which stand will cull-tree removal provide the greatest increase in value growth? What specific forestry practices should be favored by cost-sharing programs? Planting? Cleaning? Pest Control? Which pine stands offer the best opportunities for increasing pine values by weevil control?

Part of the Division's research program is designed to help answer such questions as these. Results of several years' research on three separate studies in this area were analyzed in 1959. Although detailed results of all three studies are being published elsewhere, a preview is presented here. These results show the importance of investing forest-management funds carefully. They also indicate the danger of using rules-of-thumb in place of guides based on a careful consideration of the major cost and response factors.

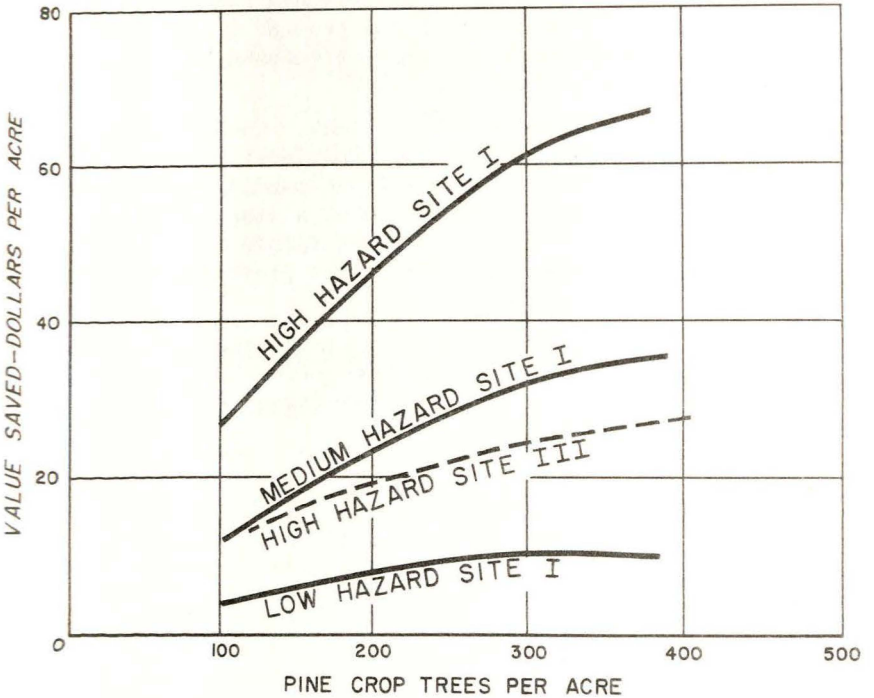
We believe that those who invest in forestry practices want to know which stands and which practices will give them the greatest value response from their investment dollars. Our studies are based on this idea.

Weevil - Control Opportunities Very Promising in Some Stands

At the request of an agency that is initiating a white-pine-weevil-control program, we helped develop economic guides for selecting the stands that have highest control priorities.

In developing these guides, our first task was to determine the average volume and quality loss expected from each weevil attack. We found that this loss varied with many factors; but the most important were attack frequency, tree size at time of attack, and tree size at harvest.

Next a method of rating weevil hazard was developed. Hazard was based on expected frequency of future weevil attacks. We also analyzed the effect of site, stocking, prospective market developments, stumpage prices, management practices, and other factors on the expected value savings from various weevil-control programs. Combining these data gave us a series of charts, of which the following figure is an example.



VALUE SAVED by weevil control in young white pine stands is affected by stocking, weevil hazard, and site.

This chart shows why crop-tree stocking, weevil hazard, and site must all be considered in deciding which stands to work in. For example, note that on Site I, expected value-savings are 6 times as much in stands where the weevil hazard is high as in stands where the hazard is low.

Such differences are even more striking when control costs are introduced. Costs are not shown because they vary widely, depending on still other factors. But to illustrate, use a rough figure of $10 per acre, and note the difference in return per dollar of cost under various stand conditions.

Thinning Rates High Priority in Pennsylvania

In a similar study, three timber-management opportunities in Pennsylvania were analyzed. The specific opportunities evaluated were: (1) planting softwoods on open and lightly stocked forest land, (2) cleaning and cull-tree removal in hardwood seedling-and-sapling stands, and (3) thinning in hardwood poletimber stands. This study, carried out with the cooperation of the Pennsylvania Department of Forests and Waters, was designed to provide guides for allocating forest-management funds so as to produce the largest possible increase in timber values.

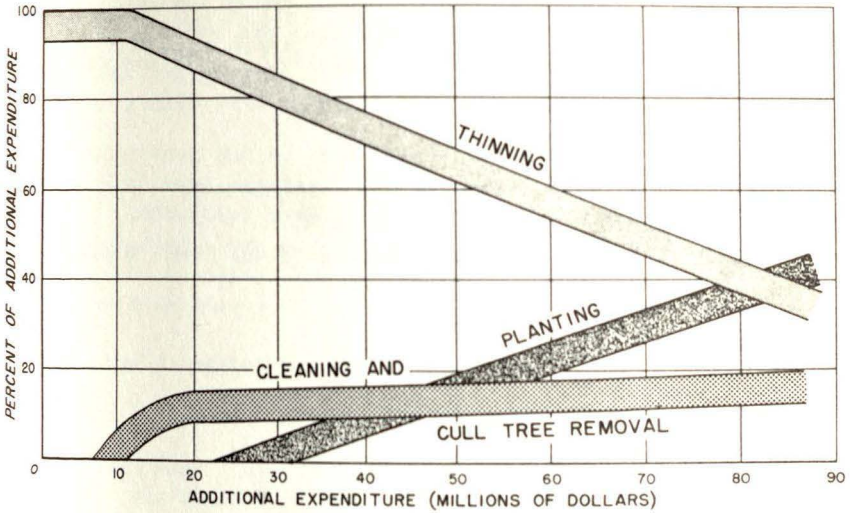
As in the weevil-control study, these opportunities were evaluated by comparing treatment cost and value of response in various treatment and stand-condition classes. In addition, however, this study went a step farther: these guides were applied to an extensive sample of stand-conditions in Pennsylvania's forests, thus providing an estimate of the area in each treatment class.

For example, 6 of the 23 classes that we evaluated are compared in the following tabulation. Note the range and extent of the investment opportunities offered by these forestry practices in Pennsylvania.

Treatment and stand-condition class	Cost per unit of value response	Class acreage
	Dollars	Thousand acres
Thinning--northern hardwood poletimber stands, Site I	4	243
Thinning--cove hardwood poletimber stands, Site I	4	12
Cleaning and cull-tree removal--northern hardwood seedling-sapling stands, Site I	7	42
Planting--bare land, Site I	11	68
Thinning--oak poletimber stands, Site 3	76	816
Planting--scrub oak stands, too rocky for root rake site preparation	470	60

A complete tabulation of these opportunities indicated that among the forestry practices evaluated, timber production can be increased most efficiently by thinning

certain kinds of stands. The figure below illustrates this point. For example, it shows that if Pennsylvania should get a 5-million dollar increase in expenditures for the next few years, all of it should be devoted to thinning, if timber is to be produced at minimum cost. And even for much larger investments, thinning should be emphasized.



COMPARISON of three timber-management opportunities in Pennsylvania indicates that the funds available could be spent most profitably for thinning.

The tabulation also indicated that profitable management opportunities in Pennsylvania are indeed numerous. According to our estimate, more than 70-million dollars could be profitably invested in these practices during the next 5 years!

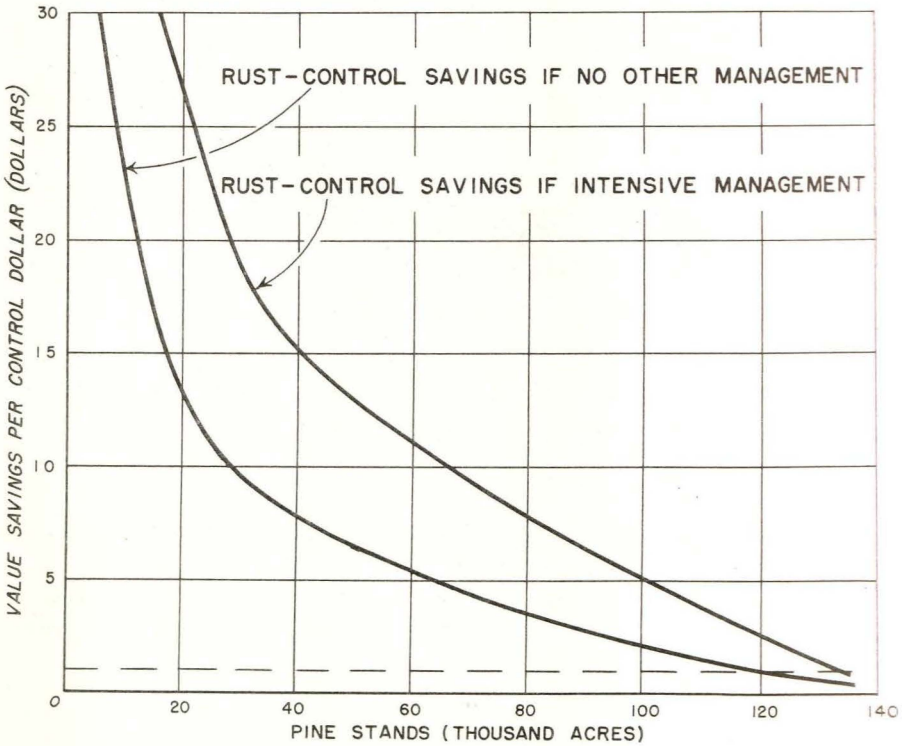
Great Variation in Returns from Blister Rust Control

A third study completed this year was an economic analysis of the blister-rust control program in Minnesota, Michigan, and Wisconsin. This study was conducted over the past 3 years in cooperation with other units of the U.S. Forest Service.

As in the two studies just described, value response per dollar of control cost was used as a basis for rating stands as potential sites for rust control. Here again, the first step was to determine what factors influence either

the costs of control or the prospective benefits from control. After making a careful analysis of the specific effects of each of these factors, a control-opportunity guide was developed. This guide is for use in individual pine stands to estimate the value response per dollar of control cost.

Then, as in the Pennsylvania study, a random sample of white pine stands was selected. Using the guide, an appraisal of rust-control opportunities was made in each. The figure below shows some of the results. Note how much more



ECONOMIC analysis of blister-rust control shows that profitability varies from stand to stand, and with intensity of management.

promising the opportunities are in certain stands as compared with others (shown by the sloping curve). Note also how much more profitable the protection opportunities are if other management practices are applied.

All three of these studies are examples of economic analyses designed to assist in allocating forest management funds efficiently. More studies of this type are being planned.

Progress on Other Studies

Work continues on the development of improved lumber-log grades for eastern white pine. During the year we conducted performance tests on woods-run logs at eight sawmills. Analyses are being made to see if average grade yields differ significantly with size of mill or location.

Other work during the year included cooperating with seven agricultural experiment stations in regional marketing research; conducting a case study of the economics of converting low-grade logs into chips; and the publication of a paper on the relationship of ownership characteristics to forestry practices.

FOREST SURVEY

Field work for the initial Forest Survey in the Northeast was begun in 1946 and completed in 1958. This survey covered a total of about 76 million acres of forest land from West Virginia to Maine.

Current information on timber resources in the Northeast is needed to provide a basis for policy and action decisions on national, regional, state, and local levels. We need more information about changes and trends in our resources and additional information in line with recent forestry developments. For these purposes we plan to conduct a continuing resurvey of the Northeastern Region.

In preparation for this, technique studies and plans for the resurvey have been in progress during recent years. These have been developed to the extent that 1959 marks the year of the second survey of New Hampshire and also the start of field work for the second survey of West Virginia. Problems are raised in designing an efficient sampling plan for the resurvey that were not encountered in the initial survey. The theory for this sampling design is still developing and current studies are offering solutions to many of our problems.

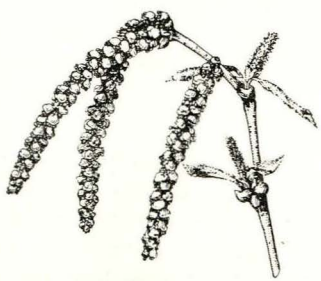
The initial Northeastern survey design may be described as a double sampling in which large numbers of photo plots were classified to define strata of land, in relation to land use, and volume per acre on forest land. A subsample of these photo plots was examined on the ground and

permanent plots were established to obtain volume means and variances by strata.

Our sampling design must provide needed statistics at lowest cost on area, volume, growth, and amount of timber cut. Indications are that we will obtain these required statistics with only about one half the total number of plots needed in the initial survey. We can efficiently make use of initial survey data by remeasuring only a sample of the initial plots and then establishing some additional new ground plots.

We plan to remeasure a sample of initial survey plots to meet accuracy requirements with respect to growth. These same remeasured plots will also provide the basis for regression equations to assist in the estimation of current volume. Interpretation of new aerial photographs will provide an up to date stratification of land area and from these photo plots a sample will be selected and established in the field as new ground plots. There will be enough of these new ground plots, together with the remeasured plots and photo plots, to meet accuracy requirements for forest area, current inventory volume, timber cut, and growth.

These features are fundamental to current survey work in New Hampshire and in West Virginia. During 1959, crews in New Hampshire completed the photo interpretation of new aerial photographs and remeasured some field plots from the initial survey and established new ground plots. In West Virginia field work has consisted only of the remeasurement of plots from the initial survey of the state. Research center personnel have participated in remeasuring plots and establishing new ground plots. This effort has been possible by the transfer of personnel and funds to the respective research centers to include forest survey in their program. Additional work is necessary in both states before resurvey data will be available.



Forest Utilization

Hardwood Utilization

THE year 1959 marked the culmination of 15 years of effort by the Division of Forest Utilization Research (FUR) at the Station to lead the way toward more intelligent and profitable use of northeastern hardwoods. Many other agencies and individuals have cooperated in various phases of this effort, and some--especially equipment makers--have supplemented the program with research of their own. A degree of success can be reported.

One of the outstanding changes has occurred in the pulp and paper industry. In 1944, according to War Production Board data, only 8 percent of the pulpwood received at northeastern mills was dense hardwood. In 1959 more than 30 percent of the wood received at northeastern pulp mills was dense hardwood. Many factors have contributed to this change-over. Among them are the increasing scarcity and the consequent high price of spruce and fir pulpwood, and embargoes on exports of pulpwood from several Canadian provinces. Tighter controls on stream pollution in several northeastern states have made operation of sulfite process mills unattractive. But more effective use of hardwoods for pulp has been made possible by research, notably at the U. S. Forest Products Laboratory.

During the 15-year-period the Northeastern Station has sponsored two surveys, in cooperation with Forest Products Laboratory technicians, during which visits were made to practically all the pulp mills in the Northeast. The purposes were to acquaint the management and staff at these mills with new developments in hardwood pulping and to acquaint the Laboratory men with the problems of the industry in the Northeast. Continuing close liaison has been maintained with the pulpmill technical staffs and their wood-procurement personnel. Several conferences on hardwood pulping have been held. The end of this change-over is not yet in sight. Plans for practically all of the proposed new pulp mills in the Northeast are based on use of hardwood.

Notable success has also been attained in the improvement of the hardwood sawmill industry in the Northeast,

and in further manufacture of the products of these sawmills. The cut of hardwood sawlogs more than doubled in the region between 1944 and 1959. Hardwoods now constitute more than 50 percent of total northeastern lumber production, and hardwood sawmilling has become by far the most profitable segment of the northeastern lumber industry. Of the 50 new pushbutton-operated mills in the Northeast, 44 were erected primarily to cut hardwoods.

The Station has been particularly active in the field of hardwood sawmilling. Staff members have participated in more than 30 small sawmill clinics during the 15-year period. At each of these, demonstrations were given of sawing hardwood logs for maximum grade recovery, of log and lumber grading, and of sawing frozen, oversize, and other types of logs whose manufacture presented difficulties. In addition, a number of articles on the subject have been prepared for the trade and technical press, talks have been given, and programs have been organized for meetings of trade and technical groups.

Much effort has also been devoted to further manufacture of the products of hardwood sawmills. Staff members have participated in about a dozen dry-kiln clinics, and have helped arrange the programs of two kiln-drying associations.

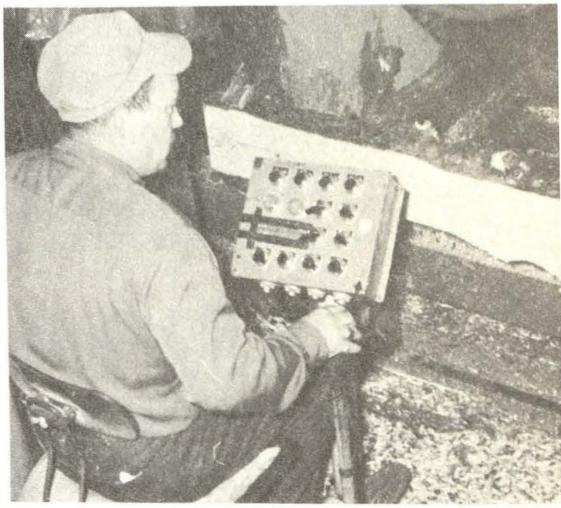
Staff members have also been active in the fields of machining, gluing, assembling, and finishing hardwood articles. During 1959 studies were made and help given in the establishment of five new plants to make hardwood dimension stock, three to make laminated bowling pins, two to make hardwood flooring and paneling, and one to make laminated truck-body beds and edge-glued table tops.

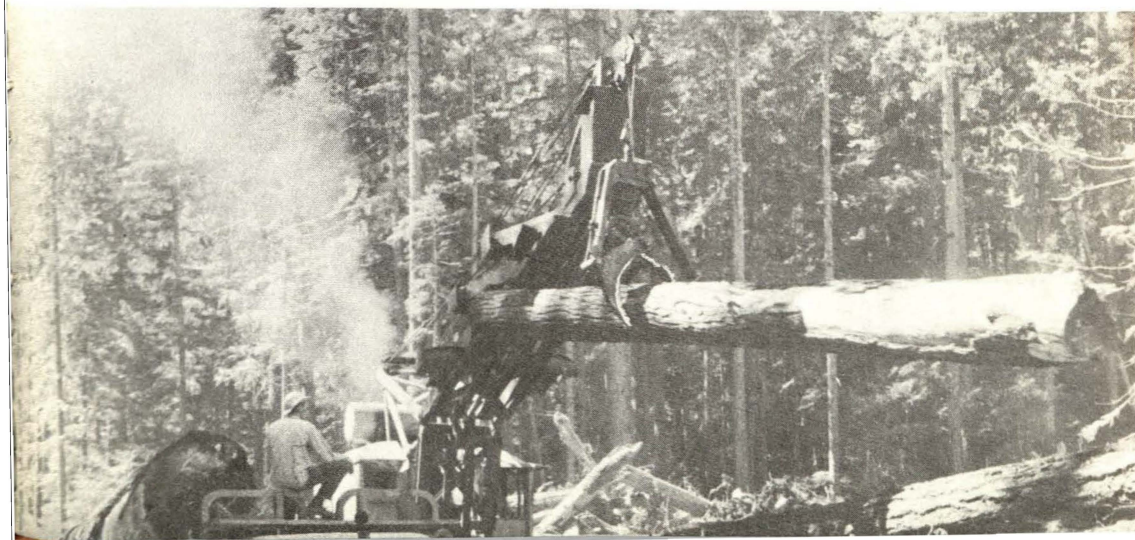
The Northeastern hardwood charcoal industry has also been undergoing a revival. As recently as 1956, charcoal production in this section of the country was only about 30,000 tons. In 1959 it was estimated to be in excess of 50,000 tons, and new charcoal manufacturing plants are being erected throughout the region. Instrumental in this revival have been a very successful Station-sponsored conference on manufacturing and marketing charcoal held at New Haven in 1957, and widespread distribution of a Station publication, "Guides to Manufacturing and Marketing Charcoal in the Northeastern States", first published in 1957. These guides dealt largely with methods of producing charcoal in relatively small establishments by means of kilns. Activity and interest has shifted recently to larger and more efficient methods of manufacturing charcoal by means of vertical and horizontal retorts.

NEW logging equipment. Top: a 4-wheel skidding tractor hauling tree-length hardwoods in the Adirondacks.

Center: sawyer at push-button controls of new automatic-carriage sawmill in Maine. →

Bottom: automatic log grapple, one of the new loading devices. ↓





REVIVAL in the charcoal industry has produced new manufacturing methods. Above: the Thomas simple vertical retort in operation on a woodlot in the Pocono Mountains of Pennsylvania.

Below: Tar Boy vertical charcoal retorts in use at a charcoal operation at Dolgeville, New York

All of these developments are aimed toward more efficient and more profitable use of the sizes and qualities of hardwood sawtimber and poletimber available in quantity from northeastern timber stands. Utilization of such material makes possible more widespread forest management in the Northeast. That a lot remains to be done is evidenced by the fact that even today the Northeast is using only about 60 percent of its hardwood sawtimber growth and only about 35 percent of the growth of hardwood poletimber.

Beech Utilization Project

The year 1959 also marked the culmination of the beech utilization project, sponsored by the Northeastern Station in cooperation with 14 other research agencies. Representatives of these 15 institutions served on the Northeastern Technical Committee on Utilization of Beech, organized in 1950, which has prepared to date 20 reports on various phases of the beech-utilization problem. The manuscript for the 21st and final report is now in process of preparation. The reports have been published and distributed by the Station.

In November 1958 a conference on "Better Utilization of Beech", sponsored by the Utilization Division of the Northeastern Loggers Association, was held at Montpelier, Vt. This summarized and brought up to date the contents of the beech utilization papers. The proceedings of the conference were published in the February and November 1959 issues of the NORTHEASTERN LOGGER magazine.

As a result of this conference, the Northeastern Beech Council was organized. This is sponsored by seven wood-using industry trade organizations, with four publicly-supported research institutions acting in an advisory capacity. The object of the Council will be to promote better and more widespread use of northeastern beech. A station staff member is chairman of the research division of the Council. Continued research on utilization of beech, including large-scale tests of its utility for various purposes, is planned.

Logging

Another of our major activities in utilization through the years has been an attempt to improve logging methods and practices in the Northeastern States. To this end many operations have been visited each year to observe and evaluate new methods and equipment. The most promising of these have subsequently been reported in trade journal articles, bulletins, talks, and the like.

This activity continued during 1959 with visits to operations in Canada and on the West Coast, as well as to northeastern operations. Items publicized include new 7- and 12-cord pulpwood pallets developed on Scott Paper Company operations in Maine; a new radio-controlled skidder developed by a Hanover, Mass., logger; the new muskeg skidding tractors, mounted on tracks running over pneumatic tires, introduced by a Canadian concern; and the widespread use of the safer and more efficient grapples instead of tongs for log loading.

Use of Mill Residues

Considerable work was also done in the field of more intensive use of mill residues. Further observations were made, and data collected, at community chipping plants, at sawdust processing plants, at particle-board plants, and at charcoal plants in the Northeast. A conference on "More Profitable Use of Mill Residues" was held at Glens Falls, N. Y., in November under the joint sponsorship of the Utilization Division of the Northeastern Loggers Association and the Small Business Administration of the New York State Department of Commerce.

General

In addition to the broad programs and cooperative studies, individual attention was given to requests for information and advice. During 1959 the Station received about 600 inquiries on utilization matters, of which about a third could be answered by sending one or more publications of the Station or the Forest Products Laboratory. About two thirds required a written answer, some of which ran to several pages, a few inquiries had to be forwarded to specialists at the Forest Products Laboratory or other institutions for adequate reply.

These requests ran the gamut of utilization subjects, from logging methods and equipment to furniture finishing and marketing. Most of them, of course, originated in the Northeast, but many came from other regions and even from foreign countries. For example, answers were made to inquiries from Australia on cable logging, from Italy on methods of stump removal, from Peru on sawing dense hardwoods, from Japan on charcoal manufacture, and from Hawaii on the economic size for hardwood sawmills. Interest in beech utilization was particularly widespread. Inquiries on this subject were received from almost every part of the United States and Canada, and from Yugoslavia, England, and Japan.

Publications

in 1959 by staff members and cooperators of the Northeastern Forest Experiment Station, Forest Service, U. S. Dept. of Agriculture.

Amidon, Elliot L., and Stoltenberg, Carl H.
1959. AVAILABILITY OF BEECH IN THE NORTHEAST.
Northeast. Logger 7 (8): 12-15, illus.
A large quantity of beech timber meets the requirements for sawtimber, pulpwood, and other uses; and beech is growing more volume than is being cut.

*---------- and Stoltenberg, Carl H.
1959. AVAILABILITY OF BEECH IN THE NORTHEAST. Northeast. Tech. Com. Util. Beech and Northeast. Forest Expt. Sta., Beech Util. Ser. 19. 14 pp., illus.
Summarizes what is known and can be predicted about the forest inventory of beech in the Northeast. Volume of beech sawtimber in the Northeast totals nearly 9 billion board-feet.

*Andresen, John W.
1959. A STUDY OF PSEUDO-NANISM IN PINUS RIGIDA MILL.
Ecol. Monog. 29: 309-332.
Study of stunted coppice forests of Pinus rigida in New Jersey indicates that repeated burning is the primary cause of dwarfism, not toxic quantities of soluble aluminum in the soil.

Brown, Raymond C.
1959. INSECT DAMAGE AND CONTROL. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 20-22.
Nearly 50 insect species attack eastern white pine. Describes in detail the damage done by the three major enemies--cone beetle, Pales weevil, and white-pine weevil--and methods of control.

*Connola, D. P., Waters, W. E., and Nason, E. R.
1959. A SEQUENTIAL SAMPLING PLAN FOR RED-PINE SAWFLY NEODIPRION NANULUS SCHEDL. Jour. Econ. Ent. 52: 600-602.
A sequential sampling plan based on egg-infested needles found on 6-inch twig samples is presented. The confidence levels for the plan were set at 90 percent.

---

*Copies or reprints available from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

Diller, Jesse D.

1959. THE TIN-CAN METHOD FOR PROTECTING CHESTNUT SEEDBEDS FROM RODENTS. North. Nut Growers Assoc. Ann. Rpt. 49: 44-46.
Excavated seedbeds were fitted with 1-quart cans (top cut off and a hole punched in the bottom), and nuts were planted in loose soil in the cans, one to a can.

*---------- and Koch, E. J.

1959. WEIGHT LOSSES OF 40 WOOD SPECIES EXPOSED TO PORIA INCRASSATA AND MERULIUS LACRYMANS. Forest Prod. Jour. 9: 298-302, illus.
Forty species of wood were exposed to the fungi for 2 years under mounds of forest leaves. All 23 U.S.-grown wood species showed some weight loss.

Doolittle, Warren T.

1959. REVIEW OF CURRENT FEDERAL AND STATE PROGRAMS IN FOREST TREE NUTRITION RESEARCH. In Mineral nutrition of trees, a symposium. Duke Univ. School Forestry Bul. 15: 161-172.
Discusses current work in nurseries, seed production, seedling growth, tree growth, and basic nutrition. Cites four areas of nutrition research that need special attention.

*Dowden, Philip B.

1959. WHAT ABOUT BIOLOGICAL CONTROL?
Jour. Forestry 57: 267-270, illus.
Describes developments in use of biotic factors for controlling forest insect pests, including use of parasites, predators, pathogens, and sterilization through radiation.

*---------- and Blaisdell, H. L.

1959. GYPSY MOTH.
U.S. Dept. Agr. Forest Pest Leaflet 41. 4 pp., illus.
Describes the gypsy moth (Porthetria dispar L.), now one of the most widely known forest insects: distribution, life history and habits, host trees, damage done, and control measures.

*Fenton, Richard H.

1959. HEAVY SNOWFALLS DAMAGE VIRGINIA PINE.
Northeast. Forest Expt. Sta., Sta. Paper 127. 7 pp., illus.
Dense sapling stands were badly damaged by heavy snowfalls in the winter of 1957-58 at Beltsville, Md. Young trees were bent over but recovered, and larger trees resisted damage.

*----------

1959. CHARCOAL FROM CHEMI-PEELED HARDWOODS.
Northeast. Forest Expt. Sta. Forest Res. Note 94. 4 pp., illus.
Low-grade timber for charcoal, killed and chemi-peeled with sodium arsenite and left standing until needed, yielded 11 percent more charcoal by weight than equal volumes of rough wood.

*Ferguson, Roland H.

1959. THE TIMBER RESOURCES OF DELAWARE.
Northeast. Forest Expt. Sta. 30 pp., illus.
A report on the findings of the Forest Survey: use of the timber resource, the timber inventory, prospective changes in the timber supply, the opportunities in forestry.

Fowler, Marvin E.

1959. OAK WILT.
Va. Forests 14 (4): 9-11, 26, illus.
Describes distribution, hosts, symptoms, spread, damage, and control of disease caused by fungus Ceratocystis fagacearum.

Fowler, Marvin E.

1959. THE DECAY-CULL PROBLEM IN OUR FORESTS.
Conn. Arborist 13 (2): 2-5.
Though we do not have all the information we need to solve decay problems, we can reduce decay cull in New England forests by making full use of the information we do have.

1959. PARASITIC MISTLETOE, ANCIENT FESTIVE SYMBOL.
Horticulture 37: 603, illus.
Describes the American mistletoes (Phoradendron flavescens, Ph. longispicum and Ph. villosum) used for yuletide decoration. Notes on harvesting and propagation.

1959. A BRIEF HISTORY OF THE ART AND SCIENCE OF TENDING TREES.
N.Y. Bot. Gard., Garden Jour. 9: 120-121, 126.
Traces the art of arboriculture from ancient times, through the beginnings of scientific method, to the emergence of forestry as a science a half century ago.

1959. (A HISTORY OF THE ART AND SCIENCE OF TENDING TREES.)
City Parks Assoc. Ann. Rpt. 1958: 9-16.
(See above.)

*---

1959. PREVENT TANBARK DETERIORATION.
U.S. Dept. Agr. Leaflet 286. 8 pp., illus.
Simple instructions in practices of peeling and curing tanbark to prevent losses from deterioration.

1959. DISEASE DAMAGE & CONTROL. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 23-26.
Describes the disease enemies of white pine--including blister rust, cankers and diebacks, wood decays, root rots, and foliage diseases--and the need for better methods of control.

*Garland, Lloyd E., Pierce, Robert S., and Trimble, George R., Jr.

1959. A SOIL SURVEY OF FOREST LAND.
Jour. Soil and Water Conserv. 14: 199-204, illus.
Methods used and results of a forest soil survey made on the Hubbard Brook Experimental Forest in New Hampshire.

*Gertel, Karl, Frey, John C., and Marty, Robert J.

1959. AN ECONOMIC APPRAISAL OF USE OF IDLE LAND IN POTTER COUNTY, PENNSYLVANIA, FOR CROPS. Pa. State Univ. Agr. Expt. Sta. Bul. 642. 46 pp.
Report on the economic feasibility of using 40,000 acres of idle land in Potter County for cropland, pasture, and forestry under conditions and skills prevalent in the county and at prices that may be expected in the future.

*Gilbert, Adrian M.

1959. SAMPLING THE QUALITY OF HARDWOOD TREES.
Northeast. Forest Expt. Sta., Sta. Paper 114. 18 pp., illus.
A tree-quality sampling method proposed for use in determining number of trees needed for estimating total value of growing stock.

*Gilbert, Adrian M., and Larson, Edwin vH.
1959. "B" IS FOR BIRCH.
N.Y. Bot. Gard., Garden Jour. 9: 132-135, illus.
Describes the five birch species native to eastern North America, with remarks on the unusual prominence of the birches in mythology and folklore.

*Grisez, Ted J.
1959. A LOW-COST DEER FENCE.
Jour. Forestry 57: 42-43, illus.
Describes the erection of a low-cost 8-foot fence successfully used to deer-proof a stand of reproduction on the Pocono Experimental Forest.

*----------
1959. THE HICKORY RUN DEER ENCLOSURE.
Northeast. Forest Expt. Sta. Forest Res. Note 87. 4 pp., illus.
Comparison of vegetation inside and outside an area protected by deer-proof fence demonstrates that browsing by an excessive deer herd in Pennsylvania prevents natural forest regeneration.

*----------
1959. THE HICKORY RUN DEER EXCLOSURE.
Northeast. Forest Expt. Sta. 1 pp., illus.
Hand-out sheet explaining briefly the research findings at the Hickory Run deer exclosure. See above.

*Hacskaylo, Edward, and Snow, Albert G., Jr.
1959. RELATION OF SOIL NUTRIENTS AND LIGHT TO PREVALENCE OF MYCORRHIZAE ON PINE SEEDLINGS. Northeast. Forest Expt. Sta., Sta. Paper 125. 13 pp., illus.
A report on one aspect of studies to determine effects of different nutrient levels and exposure to supplemental light on Virginia pine, loblolly pine, and eastern white pine seedlings.

*Hampf, Frederick E., and Bickford, C. Allen.
1959. A METHOD OF ESTIMATING CUBIC VOLUME IN FELLED TREES.
Northeast. Forest Expt. Sta., Sta. Paper 117. 11 pp., illus.
Gives computations required and examples of procedures for this method, which is faster than measuring by planimeter and more accurate than estimating by whole-tree volume tables.

*Hart, Arthur C.
1959. SILVICAL CHARACTERISTICS OF BALSAM FIR (ABIES BALSAMEA).
Northeast. Forest Expt. Sta., Sta. Paper 122. 22 pp., illus.
Describes natural range and habitat conditions, life history, growth and yield, disease and insect pests of this important northern conifer.

*----------
1959. SILVICAL CHARACTERISTICS OF RED SPRUCE (PICEA RUBENS).
Northeast. Forest Expt. Sta., Sta. Paper 124. 18 pp., illus.
Describes this most valuable of the spruces, its natural range, habitat conditions, life history, and special features. In the variety of its uses, red spruce rivals white pine.

*----------
1959. REPORT ON 1958 FOREST TREE SEED CROP IN NEW ENGLAND.
Northeast. Forest Expt. Sta. Forest Res. Note 86. 2 pp., illus.
A summary of seed-crop reports from the six states of New England for 25 forest tree species. Seed crops in 1958 were considerably better than those in 1957.

*Hart, Arthur C., and Bissell, Lewis P.
1959. FARM WOODLOTS: COSTS AND INCOME.
Maine Agr. Ext. Serv. Circ. 338. 12 pp., illus.
Records of the first 5 years of woodlot management on the Penobscot Experimental Forest in Maine demonstrate that productivity of the small woodlot can be increased by use of simple management methods.

*---------- and Byrnes, William R.
1959. PERFORMANCE OF TREES PLANTED ON COAL-STRIPPED LANDS IN THE BITUMINOUS REGION OF PENNSYLVANIA. Pa. State Forest School Res. Paper 28. 2 pp.
Summary of results after 10-13 years, rating tested species by height, survival, vigor, and pest damage. Hybrid poplar, black locust, red oak, Japanese larch, Banks pine, and Scotch pine seem most promising.

---------- and Byrnes, William R.
1959. SEVERAL TREE SPECIES SUCCEED ON COAL-STRIPPED LANDS.
Pa. State Univ. Science for Farmer 7 (1): 5, illus.
(See above.)

*Hough, A. F.
1959. ZONING FOR THE MANAGEMENT OF BLACK CHERRY ON THE ALLEGHENY PLATEAU. Jour. Forestry 57: 353-357, illus.
Elevation and forest associations are used for delineating forest zones where this valuable timber species can be perpetuated with relatively little risk of damage from glaze storms.

Lane, Richard D.
1959. VOLUME GROWTH AND QUALITY. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 5-6.
Present low quality of white pine in the Northeast does not reflect the potential of the species. The intrinsic quality of the wood is high, and management practices can produce trees of good quality.

1959. WHAT IS A QUALITY TREE? In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 7-11.
Examination of quality features of white pine trees leads to a conclusion that through protection, site selection, stocking control, and artificial pruning we have or soon will have the means to produce just the kind of tree we want.

1959. MANAGING YOUNG STANDS FOR QUALITY PRODUCTION. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 45-55.
Production of high-quality white pine must begin in young stands. Discusses need for and methods of protection, weeding, and releasing, thinning, and pruning.

(Larson, E. vH., and Smith, W. E.)
1959. SPECIAL REPORT ON WHITE PINE.
Soc. Protect. N.H. Forests, Forest Notes 63: 22.
Resume of Northeastern Station publication, "What's known about managing eastern white pine". Also appeared, as news release, in various newspapers and trade journals. See also Mass. Forest and Park News 23 (4): 4.

*Leak, William B.

1959. DEVELOPMENT OF YELLOW BIRCH NURSERY STOCK NOT AFFECTED BY TRANSPLANTING. Northeast. Forest Expt. Sta. Forest Res. Note 91. 4 pp., illus.
In seedbeds, severe root competition develops among yellow birch seedlings because of their wide-spreading root systems. Transplanting and root-pruning produced no change in form or structure of root systems.

*Lewis, Franklin B.

1959. ABUNDANCE AND SEASONAL DISTRIBUTION OF THE COMMON SPECIES OF CERATOPOGONIDAE (DIPTERA) OCCURRING IN THE STATE OF CONNECTICUT. Canad. Ent. 91: 15-28.
Previously only four genera containing eight species of ceratopogonids had been reported from Connecticut. This report increases the genera list to 16, the number of species to 82.

Little, S.

1959. A PROGRESS REPORT ON TESTS OF CONTROLLING JAPANESE HONEYSUCKLE. Northeast. Weed Control Conf. Proc. 13: 360-366.
Japanese honeysuckle hinders forest management in parts of the Middle Atlantic States. Grazing and burning do not eliminate it; and herbicides tested are not effective--even after 2 or 3 treatments.

*----------

1959. SILVICAL CHARACTERISTICS OF ATLANTIC WHITE-CEDAR (CHAMAECYPARIS THYOIDES). Northeast. Forest Expt. Sta., Sta. Paper 118. 16 pp., illus.
A description of the species and its habitat conditions, as well as its life history--seeding habits, vegetative reproduction, seedling development, sapling stage through maturity.

*----------

1959. SILVICAL CHARACTERISTICS OF PITCH PINE (PINUS RIGIDA). Northeast. Forest Expt. Sta., Sta. Paper 119. 22 pp., illus.
Describes the species, its distribution, habitat conditions, and life history (seeding habits, vegetative reproduction, seedling development, sapling stage to maturity).

*---------- Lull, Howard W., and Remson, Irwin.

1959. CHANGES IN WOODLAND VEGETATION AND SOILS AFTER SPRAYING LARGE AMOUNTS OF WASTE WATER. Forest Sci. 5: 18-27, illus.
Spraying 400-600 inches a year of waste water from a food processing plant killed off practically all trees and native shrubs and herbs. Rank growth of elder developed.

*---------- and Somes, H. A.

1959. VIABILITY OF LOBLOLLY PINE SEED STORED IN THE FOREST FLOOR. Jour. Forestry 57: 848-849.
From a study conducted in Maryland, it seems evident that very few loblolly pine seeds remain viable in the forest floor through the second winter after they mature.

*---------- and Tepper, H. B.

1959. SIX-YEAR RESULTS FROM A MARYLAND PLANTING OF LOBLOLLY PINES FROM DIFFERENT SEED SOURCES. Northeast. Forest Tree Improve. Conf. Proc. 6: 26-29.
Studies in Maryland indicate that more rapid growth of southern stock cannot be realized under northern conditions. Local sources seem best.

Lockard, C. R.
1959. LOG GRADES...THEIR PRACTICAL APPLICATION.
Northeast Logger 7 (9): 10-11, 30-31, 36-37, illus.
Describes the theoretical basis for log-grading, efforts to develop workable log-grading systems, and practical applications in harvesting, bucking practices, log purchasing and selling, and sawmilling.

1959. SCIENTIFIC TIMBER QUALITY EVALUATION--A LUMBER INDUSTRY "MUST".
Forest Prod. Jour. 9: 282-284.
The lumber industry would profit greatly from a log-grade system based on research. Describes objectives and applications of such a system.

1959. MARKETS & PRODUCTS FOR EASTERN WHITE PINE. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 1-4.
Maintenance and expansion of the white pine industry is possible if forest landowners use existing knowledge of quality factors to guide their timber-growing and marketing practices.

--- and McQuilkin, William E.
1959. MANAGING MERCHANTABLE STANDS FOR QUALITY PRODUCTION. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 56-60.
Discusses methods and time for harvesting to insure continuous production from white pine stands. Sees need for "engineering" trees in managed forests to produce profit-bearing high-grade timber.

*Lull, Howard W.
1959. SOIL COMPACTION ON FOREST AND RANGE LANDS.
U.S. Dept. Agr. Misc. Pub. 768. 33 pp., illus.
A review of the literature on soil compaction: the compaction process; the extent of compaction in relation to forest and range use; the effects of compaction on soils, erosion, surface runoff, streamflow, and site quality; remedies for compaction and methods of preventing or minimizing it.

*---
1959. HUMUS DEPTH IN THE NORTHEAST.
Jour. Forestry 57: 905-909, illus.
A look through history at depth of forest humus, comparing virgin forests with present conditions and discussing potential and actual depths.

*--- and Pierce, Robert S.
1959. FROST AND FOREST SOIL.
Internatl. Union Geodesy and Geophys. Pub. 48 vol. 1: 40-48.
Paper given at Hannoversch-Muenden symposium, presenting average depths of concrete frost in 14 forest-condition classes in the Northeast, as compared with frost conditions in four open-land class-use conditions.

*McClung, Lester, and Trimble, George R., Jr.
1959. WEALTH OF THE FOREST.
W. Va. Conserv. 23 (6): 5-7, illus.
The first of a 2-part picture story, dealing with woodland grazing, water, fire, and planting.

*McClung, Lester, and Trimble, George R., Jr.
1959. WEALTH OF OUR FOREST.
W. Va. Conserv. 23 (7): 20-23, illus.
Second installment of a picture story that tells how to practice better forestry. Deals with timber quality, logging methods, removal of cull trees, and the need for more stocking.

McConkey, Thomas W.
1959. HELICOPTERS AND TREE PLANTERS MAKE NEW FORESTS.
Northeast. Logger 7 (11): 24-25, 51-55, illus.
Describes the problem of reforesting burned-over white pine lands in Maine, and use of brush-killing chemicals, applied by helicopter, to release pine from competition.

*McLintock, T. F.
1959. A METHOD OF OBTAINING SOIL-SAMPLE VOLUMES IN STONY SOILS.
Jour. Forestry 57: 832-834.
Describes a method of taking soil samples in rocky New England soils. Despite some limitations, the method proved accurate, consistent, and reasonably easy to carry out.

*----------
1959. SOIL MOISTURE PATTERNS IN A NORTHERN CONIFEROUS FOREST.
Northeast. Forest Expt. Sta., Sta. Paper 128. 5 pp., illus.
A brief summary of major soil-moisture trends and a discussion of differences as related to the hummock-and-hollow typography of the northern softwood forest region.

McQuilkin, William E.
1959. EFFECT OF SITE & STOCKING ON REPRODUCTION. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 16-19.
For obtaining white pine regeneration one must work largely with the plant cover to provide conditions that minimize heat injury, reduce competition for soil moisture, and give seedlings adequate light for good growth.

1959. ESTABLISHING WHITE PINE ON OPEN LAND. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121. 31-44.
White pine poses no special difficulties to establishment on open land. Discusses site preparation and regeneration methods, including natural seeding, direct artificial seeding, planting, and spacing.

Marquis, Ralph W.
1959. IN CONCLUSION... In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 61-62.
The future of white pine rests entirely on the assumption that sales, manufacture, and timber management will emphasize the quality aspect. This all depends on the forest land owner and what he does to manage his stands for quality production.

1959. IMPROVING THE FOREST YIELD FROM PRIVATE WOODLOTS. Pulp and Paper Mag. Canada 60 (4): Woodlands Rev: 62-66.
Although technical information is available, a need is felt for a better way to get knowledge to owners of small forest properties. Suggests use of local committees.

*Marquis, Ralph W.

1959. BROMIDES AND FOLKLORE IN FOREST ECONOMICS.
Albert G. Hall & Associates. 6 pp. Washington, D.C.
Published originally in 1947 by the Society of American Foresters, this is a discussion of the development of economic doctrine and the influence of silvicultural bias and emotional slogans on forest economics.

*Marty, Robert J.

1959. PREDICTING WEEVIL-CAUSED VOLUME LOSS IN WHITE PINE.
Forest Sci. 5: 269-274.
Presents a formula for estimating volume losses expected from white-pine weevil attack in white pine stands; provides a partial basis for evaluating profitability of weevil-control efforts.

*Miller, Douglas R., Kimmey, James W., and Fowler, Marvin E.

1959. WHITE PINE BLISTER RUST.
U.S. Dept. Agr. Forest Pest Leaflet 36. 8 pp., illus.
Describes this disease caused by the fungus Cronartium ribicola: history, distribution, hosts, life cycle, symptoms on pines and on the alternate hosts, Ribes; and control methods.

*Mitchell, Wilfred C., and Trimble, G. R., Jr.

1959. HOW MUCH LAND IS NEEDED FOR THE LOGGING TRANSPORT SYSTEM?
Jour. Forestry 57: 10-12, illus.
Compares the amount of land needed for logging roads, trails, and skidways under the old clear-cutting methods and the more modern sustained-yield cutting practices. By careful planning, area in skidroads can be reduced about 40 percent.

*Mook, Paul V., and Waters, W. E.

1959. FOREST DISEASE AND INSECT CONDITIONS IN THE NORTHEAST--1958.
Northeast. Forest Expt. Sta., Sta. Paper 120. 39 pp.
Current status of major forest diseases and insects summarized from field reports and special surveys. Tabular summaries for major and minor diseases and insects.

*Northeastern Forest Experiment Station.

1959. ANNUAL REPORT 1958.
Northeast. Forest Expt. Sta. 74 pp., illus.
A survey of research activities and progress in the fields of forest management and fire research, watershed management, forest insects, forest diseases, forest economics, and forest utilization. Annotated list of publications.

*----------

1959. WHAT'S KNOWN ABOUT MANAGING EASTERN WHITE PINE.
Northeast. Forest Expt. Sta., Sta. Paper 121. 69 pp., illus.
A survey of available information on this species, prepared at request of Northeastern Forest Research Advisory Council as an aid to planning research programs. For contents see articles listed under Brown, Fowler, Lane, Lockard, McQuilkin, Marquis, Stoltenberg, and Wilson.

*----------

1959. BARTLETT EXPERIMENTAL FOREST.
Northeast. Forest Expt. Sta. 4 pp., illus.
Folder describing briefly the research activities on the Bartlett Experimental Forest near Bartlett, N. H., one of the field laboratories of the Laconia Research Center.

*Northeastern Forest Experiment Station.

1959. NORTHEASTERN FOREST PEST REPORTER 1 (1959). Northeast. Forest Expt. Sta. 11 pp. (New Haven.)
Early season occurrence, abundance, and developments of major forest insect and disease pests. Appraises control measures and effect of weather conditions on diseases.

*----------

1959. NORTHEASTERN FOREST PEST REPORTER 2 (1959). Northeast. Forest Expt. Sta. 7 pp. (New Haven.)
Midseason report (August) on forest insect and disease conditions.

*----------

1959. NORTHEASTERN FOREST PEST REPORTER 3 (1959). Northeast. Forest Expt. Sta. 10 pp. (New Haven.)
Fall report (October) on the status of forest pests. Cites need for more information on the climatic effects on insects.

*Reinhart, K. G., and Phillips, John J.

1959. POOR LOGGING MAKES MUDDY STREAMS. W. Va. Conservation 22 (11): 20-23, illus.
Describes experiments on Fernow Experimental Forest to determine effects of different logging methods and logging road systems on streamflow and water quality. The better logging methods not only reduce erosion but are also cheaper.

*Rogers, Earl J., Avery, Gene, and Chapman, Roy A.

1959. THREE SCALES OF AERIAL PHOTOGRAPHY COMPARED FOR MAKING STAND MEASUREMENTS. Northeast. Forest Expt. Sta. Forest Res. Note 88. 4 pp.
Airphotos at scales of 1:1,000, 1:5,000, and 1:15,840 were tested to determine the best scale for use in forest surveying. The 1:15,840 scale is recommended.

*---------- Avery, Gene, and Chapman, Roy A.

1959. SELECTION OF STAND VARIABLES IN SOUTHERN MAINE FOR MAKING VOLUME ESTIMATES FROM AERIAL PHOTOS. Northeast. Forest Expt. Sta. Forest Res. Note 89. 3 pp.
Crown closure percent was found to have the highest single correlation with gross timber volume, for use in air-photo forest surveying. Other variables tested: total tree height and tree-crown diameter.

Rushmore, Francis M.

1959. SOME EFFECTS OF SILVICIDES ON HARDWOODS. Soc. Amer. Foresters N.Y. Sect., New York Forester 16 (1): 5-6.
Observations indicate that silvicide-killed trees can be left standing several years without marked deterioration, thus storing wood on the stump.

Santamour, Frank S., Jr.

1959. BISEXUAL CONELETS IN SPRUCE. Univ. Pa. Morris Arboretum Bul. 10 (1): 10-11, illus.
Describes abnormal conelets found on 11 trees of 7 spruce species. It seems probable that the cause of abnormalities is environmental; the severe drought of 1957 may have been a factor.

*Schaffner, J. F., Jr.

1959. MICROLEPIDOPTERA AND THEIR PARASITES REARED FROM FIELD COLLEC-

TIONS IN THE NORTHEASTERN UNITED STATES. U.S. Dept. Agr. Misc. Pub. 767. 97 pp.
Annotated lists of parasites and hosts, a report on a phase of studies designed to acquire new knowledge on the distribution, food plants, life histories, and parasites of lepidopterous insects--knowledge basic for all methods of controlling forest insect pests.

*Schreiner, Ernst J.
1959. PRODUCTION OF POPLAR TIMBER IN EUROPE AND ITS SIGNIFICANCE AND APPLICATION IN THE UNITED STATES. U. S. Dept. Agr. Handbook 150. 124 pp., illus.
Report on a survey of European experience in breeding and growing poplar trees, with recommendations on European findings that would be applicable in U.S. Covers species and hybrids, selection and breeding, nursery practice, site and soil requirements, outplanting, management and silviculture, diseases, insects, damage by other agents, growth and yield, wood characteristics and utilization.

*----------
1959. A TOOL FOR PLANTING CUTTINGS.
Jour. Forestry 57: 206, illus.
Detailed plans for a foot dibble designed for planting hybrid poplar cuttings 12 inches long.

*----------
1959. RATING POPLARS FOR MELAMPSORA LEAF RUST INFECTION.
Northeast. Forest Expt. Sta. Forest Res Note 90. 3 pp., illus.
Offers leaf diagrams for use in rating hybrid poplars for light, medium, or heavy Melampsora rust infection. Trees can be rated most effectively when 1-4 years old.

Simmons, Fred C.
1959. THE KING'S ARROW LUMBER CO. OPERATES MODERN MILL AT DOVER-FOXCROFT, MAINE. Northeast. Logger 7 (7): 16-17, 40 illus.
Describes operations and equipment of this new mill. Average production is 3,000 board-feet per hour. A unique feature is the use of slot sorters for sorting lumber by size and grade.

1959. THE BEECH UTILIZATION CONFERENCE.
Northeast. Logger 7 (8): 10-11, illus.
Outlines concern over utilization of beech timber and work of the Northeastern Technical Committee on Utilization of Beech in promoting beech. Introduction to the conference held in November 1958 at Montpelier, Vt.

1959. NORTHEASTERNERS DISCUSS BETTER UTILIZATION OF BEECH.
Soc. Protect. N. H. Forests, Forest Notes 61: 14-16.
Report on the conference on utilization of beech held at Montpelier, Vt., by some 75 loggers, lumbermen, wood processors, and research workers. Summary of papers given.

1959. PROGRESS IN LOGGING--1958.
Forest Prod. Jour. 9: 67-71, illus.
The 1958 upswing in lumbering can be expected to continue in 1959. Cost and quality control practices got much attention from loggers in the past year; and larger and more versatile equipment was developed. Bibliography.

*Simmons, Fred C.

1959. NEW DEVELOPMENTS IN LOGGING AND SAWMILLING EQUIPMENT.
Forest Prod. Res. Soc. Northeast. Sect. 5 pp., illus. Rutgers Univ.
Recently a regular flood of new machinery for woods and mill operations has become available. About 50 northeastern sawmills now have pushbutton-controlled carriages.

1959. LOGGING AND MILLING BEECH AND SORTING FOR VARIOUS PRODUCTS.
Northeast. Logger 7 (8): 16-19, 42, illus.
Beech presents some special problems in handling. Discusses methods and equipment for logging, bucking, and sawing; handling lumber to prevent defects; and marketing products.

1959. LOGGING--YESTERDAY, TODAY, AND TOMORROW.
FAO/ECE/LOG/39 Add. 2, Annex 1. 6 pp. (mimeo).
Reviews developments in logging, from the old days of the ax and crosscut saw, through the revolutionary mechanization of logging after World War II, to the present integrated logging-milling-utilization practices of today.

1959. LOGGING--YESTERDAY, TODAY, AND TOMORROW.
Timber Canada (20 (9): 71-74, 118, illus.
(See above.)

1959. LOGGING--YESTERDAY, TODAY, AND TOMORROW.
South. Lumberman 199 (2489): 195-198, illus.
(See above.)

*---

1959. A SMALL SAWMILL ENTERPRISE.
U.S. Internatl. Coop. Adm. 96 pp., illus.
An operation manual designed to aid establishment of small sawmill businesses in foreign countries. Covers requirements in planning a business, choice of machinery, setting up, mill operation, marketing, cost controls.

*---

1959. PRIMARY WOOD-USING INDUSTRIES OF BRITISH HONDURAS.
U.S. Internatl. Coop. Adm. 25 pp., illus.
New edition of a 1956 report on wood utilization, forest-products industries, and sawmilling practices, based on a study made by the author on an ICA mission. Recommendations for improving utilization and milling practices.

1959. OPPORTUNITIES FOR THE UTILIZATION OF "LOW-GRADE" HARDWOODS.
Northeast. Logger 8 (1): 12-13, 30, illus.
Urges adoption of milling methods to increase yield of high-grade lumber and to develop markets for the variety of products that can be made from the great surplus of hardwood timber.

1959. THE DRYING OF LONG LUMBER vs. DIMENSION STOCK.
Forest Prod. Res. Soc. News-Digest April 1959. 2 pp. (mimeo).
Compares methods of drying hardwood dimension stock and concludes that maximum economies can be obtained by cutting dimension stock to final size before kiln-drying.

Simmons, Fred C.

1959. NORTHEAST CONTRACT LOGGING RESULTS IN GREATER PRODUCTION, LOSS IN LOG QUALITY. Timberman 60: 62, 94.
Studies have shown that contract bucking often fails to produce maximum log-grade value; that many low-grade logs are left in the woods; and that logging practices used are not good forestry practices. Suggests some remedies.

1959. LARGER PALLETS BOOST TRUCK PRODUCTION 50 PERCENT.
Timberman October 1959: 44-45, illus.
Pallets of 7- and 12-ton capacity, used with specially designed off-highway hauling equipment, increased productivity on pulpwood jobs in Maine.

Smith, Wendell E.

1959. RECREATION STUDIES BY THE FOREST SERVICE STARTED AT WARREN, PENNSYLVANIA. Conn. Forest & Park Assoc., Conn. Woodlands 24: 96.
Describes the new Warren Research Center established by the the Northeastern Forest Experiment Station to conduct research in recreational use of forest land. This is the first research center of its kind.

Snow, Albert G., Jr.

1959. (POSSIBLE APPLICATION OF HORMONES AND GROWTH REGULATORS IN FORESTRY.) Soc. Amer. Foresters N.Y. Forester 16 (1): 14-16.
Use of chemical growth regulators is well established in plant propagation, but other possibilities in forest management, watershed management, fire control, and disease and insect control need to be explored.

*---

1959. HORMONES & GROWTH REGULATORS CAN BE USEFUL TO FORESTERS.
Northeast. Forest Expt. Sta., Sta. Paper 130. 14 pp., illus.
(See above.)

*Stoltenberg, Carl H.

1959. AN INVESTMENT-OPPORTUNITY APPROACH TO FORESTRY PROGRAMMING.
Jour. Forestry 57: 547-550.
Discusses the role of forestry-practice investments in meeting forestry program objectives. Cites the need for an investment-rating system and covers basic requirements for such a system for landowners, industry, and consumers. Discussion limited to timber-producing.

1959. EVALUATING MANAGEMENT OPPORTUNITIES. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 27-31.
Economic discussion of the question: In specific stands, what returns can be expected from specific investments to maintain pine, increase its growth rate, and improve its quality?

*Tepper, H. B., and Bamford, G. T.

1959. EFFECT OF ONE LOW THINNING ON COVE AND SLOPE HARDWOODS IN THE NEW JERSEY HIGHLANDS. Northeast. Forest Expt. Sta., Sta. Paper 129. 11 pp.
Effects on a slope stand during 27 years after thinning were slight. On cove sites thinning caused yellow-poplar to form a higher proportion of the stand.

*Tepper, H. B., and Bamford, G. T.
1959. HARDWOODS ON POORLY DRAINED SITES DO NOT RESPOND TO LOW THINNING. Northeast. Forest Expt. Sta. Forest Res. Note 92. 3 pp.
Report on results of thinning in 45- and 47-year-old hardwoods on moderately productive poorly drained sites in New Jersey.

*---------- and Bamford, G. T.
1959. NATURAL REGENERATION IN BOTTOMLAND HARDWOODS OF SOUTHERN NEW JERSEY. Northeast. Forest Expt. Sta. Forest Res. Note 93. 4 pp.
Study indicates that natural reproduction will provide desirable stands when bottomland hardwoods are harvested by proper use of shelterwood system.

*Trimble, George R., Jr.
1959. LOGGING ROADS IN NORTHEASTERN MUNICIPAL WATERSHEDS.
Jour. Amer. Water Works Assoc. 51: 407-410.
Because of erosion and sedimentation hazards, logging of forested watersheds has often been considered risky. Suggests measures in logging and in planning logging roads to reduce the hazards.

1959. THE CASE FOR DIRECTIONAL FELLING.
Northeast. Logger 8 (5): 32-33, 41, 56, illus.
Jacks were used in test of directional felling as a means of easier logging, less damage to felled trees, and less hazard from blocked roads and streambeds.

*----------
1959. A PROBLEM ANALYSIS AND PROGRAM FOR WATERSHED-MANAGEMENT RESEARCH IN THE WHITE MOUNTAINS OF NEW HAMPSHIRE. Northeast. Forest Expt. Sta., Sta. Paper 116. 46 pp., illus.
An analysis of a long-range watershed-research program centered on the Hubbard Brook Experimental Forest where the effects of forests on water are being studied. The general situation, the area, and the problems of both water quality and quantity.

---------- Mitchell, Wilfred C., and Barr, Carl R.
1959. LOGGING DAMAGE SLIGHT IN PARTIAL CUTTING.
Northeast. Logger 7 (7) 12-13, 38, illus.
One question asked about partial cutting is: Doesn't it damage too many of the trees left? Research at the Fernow Experimental Forest in West Virginia indicates that the answer is No--even if timber is skidded in full tree lengths.

*Waters, William E.
1959. A QUANTITATIVE MEASURE OF AGGREGATION IN INSECTS.
Jour. Econ. Ent. 52: 1180-1184, illus.
Occurrence of insects in natural units of their habitat is best expressed as a frequency series. The negative binomial distribution has proved applicable to a wide range of insect counts, and its parameter k is a valid measure of aggregation.

*---------- and Henson, W. R.
1959. SOME SAMPLING ATTRIBUTES OF THE NEGATIVE BINOMIAL DISTRIBUTION WITH SPECIAL REFERENCE TO FOREST INSECTS. Forest Sci. 5: 397-412, illus.
An understanding of aggregative tendencies is basic to ecological research. The negative binomial series is suggested as a standard for evaluation of observed spatial distributions of forest insects.

*Webster, Henry H., and Stoltenberg, Carl H.
1959. WHAT OWNERSHIP CHARACTERISTICS ARE USEFUL IN PREDICTING RESPONSE TO FORESTRY PROGRAMS? Land Econ. 35: 292-295.
Report on a study of relationships between ownership classes and adoption of forestry programs in New York, casting doubt on the usefulness of several commonly used types of information about forest landowners.

Wilson, Robert W.
1959. EFFECT OF SITE & STOCKING ON QUALITY GROWTH. In What's known about managing eastern white pine, Northeast. Forest Expt. Sta., Sta. Paper 121: 11-16.
Reviews methods of evaluating site quality and discusses site and stocking density in relation to quality growth and volume growth of eastern white pine.

*Wright, Jonathan W.
1959. SPECIES HYBRIDIZATION IN THE WHITE PINES.
Forest Sci. 5: 210-222.
Results of 10 years' work on species hybridization with the 5-needled pines at the Northeastern Forest Experiment Station. Of 38 different species combinations tried (including reciprocals), 16 are regarded as successful, and 12 of these have been authenticated in the nursery.

*----------
1959. SILVICAL CHARACTERISTICS OF WHITE ASH (FRAXINUS AMERICANA).
Northeast. Forest Expt. Sta., Sta. Paper 123. 19 pp., illus.
The largest and most useful of the ashes. Distribution, habitat conditions, flowering and fruiting, vegetative propagation, seed germination, seedling development, growth, wood characteristics, tolerance and place in succession, genetic variation.

*----------
1959. SILVICAL CHARACTERISTICS OF GREEN ASH (FRAXINUS PENNSYLVANICA).
Northeast. Forest Expt. Sta., Sta. Paper 126. 18 pp., illus.
The most widely distributed of all the American ashes. Habitat conditions, associates, enemies, flowering and fruiting, vegetative propagation, seed handling, seedling development and growth, tolerance, and genetic variation.

*---------- and Gabriel, William J.
1959. POSSIBILITIES OF BREEDING WEEVIL-RESISTANT WHITE PINE STRAINS.
Northeast. Forest Expt. Sta., Sta. Paper 115. 35 pp., illus.
Introduced white pine and variations of eastern white pine were studied to find and develop strains that would resist weevilling. Paper summarizes results to date and lists promising possibilities for future test. Western white pine shows the most immediate promise.

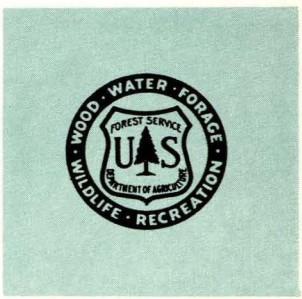
---------- and Santamour, Frank S., Jr.
1959. HARD PINES CULTIVATED IN THE PHILADELPHIA AREA.
Univ. Pa. Morris Arboretum Bul. 10: 19-29, illus.
Compares height and diameter growth of native and exotic hard pines in Philadelphia area. Discussion of racial variation and taxonomy, and key to identification of series and species. Notes on timber and horticultural uses of red pine, Scotch pine, European black pine, Mountain pine, Balkan pine, Japanese black pine--all Series Sylvestres.

Wright, Jonathan W., and Santamour, Frank S., Jr.

1959. HARD PINES CULTIVATED IN THE PHILADELPHIA AREA.
Univ. Pa. Morris Arboretum Bul. 10: 41-49, illus.
Continuation of above: Japanese red pine, Chinese pine, Masson, Yunnan, shortleaf, loblolly, longleaf, slash, ponderosa, Jeffrey, Apache, Jack, lodgepole, Virginia, Table Mountain, pitch, knobcone, Monterey, cluster, Chihuahua, and digger pines. Notes on propagation and sources of seed and nursery stock.

*Yawney, Harry W.

1959. A SOIL-DEPTH PROBE FOR SHALLOW FOREST SOILS.
Jour. Forestry 57: 435, illus.
This probe, used successfully in West Virginia, consists of a solid steel shaft 3.8 feet long, graduated in feet and inches, and a loosely fitting extraction handle. Driven with a 3-pound hammer, the probe gives measurements as deep as $3\frac{1}{2}$ feet.


WOOD · WATER · FORAGE
WILDLIFE · RECREATION
FOREST SERVICE
US
DEPARTMENT OF AGRICULTURE